THE ST. LAWRENCE NAVIGATION AND POWER PROJECT

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THE GREAT LAKES-ST. LAWRENCE WATERWAY SYSTEM

THE ST. LAWRENCE NAVIGATION AND POWER PROJECT

BY

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DIRECTOR'S PREFACE

The preparation of this volume, which considers the proposed St. Lawrence waterway in its power as well as in its transportation aspects, and with reference to both Canada and the United States, has required the coöperation of a number of people extending over a period of several years. The three designated authors have had primary responsibility for the volume as a whole. Edwin G. Nourse, Chief of the Agricultural Division of the Institute, is primarily responsible for the chapter on the relation of the proposed waterway to agricultural relief; Duncan A. MacGibbon of the University of Alberta, a Canadian authority on transportation problems, spent several months as a member of the Institute staff collaborating on the Canadian aspects of the question; and the engineering firm of Sanderson and Porter, New York, has contributed an extensive appendix (K) dealing with the marketing of the United States share of the power to be developed in the International Rapids section of the river.

The authors have also received much aid in connection with technical questions from industrial traffic managers and from steamship companies. The Supervisory Committee in connection with this volume was composed of Leverett S. Lyon, Charles O. Hardy, and Fred G. Tryon. Mr. Tryon confined his attention to the power aspects

of the problem as developed in Chapter X and Appendix K. To all those who have contributed to the making of the book, the authors express their gratitude.

HAROLD G. MOULTON,
Director.

Institute of Economics.
June, 1929.

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THE ST. LAWRENCE NAVIGATION AND POWER PROJECT

THE ST. LAWRENCE NAVIGATION AND POWER PROJECT

CHAPTER I

THE MOVEMENT FOR A ST. LAWRENCE DEEP WATERWAY

For a century plans have been periodically under discussion for constructing a deep waterway between the Atlantic Ocean and the great inland seas of the North American continent. Such projects have been considered sometimes by Canada alone, sometimes by the United States alone, and sometimes by the two countries in conjunction. Numerous alternative routes to the sea have been discussed—by the Hudson Bay, by the Georgian Bay and Ottawa River to Montreal, by the lower lakes and the St. Lawrence, and across New York to the Hudson River.[1] The project at present before the governments of the United States and Canada in concrete form calls for the construction of a deep water channel in the restricted section of the St. Lawrence from the lower end of Lake Ontario to the magnificent river which begins at Montreal.

The purpose of this opening chapter is to set forth in as concise a form as possible the economic considerations responsible for the desire to connect the Great Lakes with the Atlantic and the present status of the movement.

[1] See frontispiece map.

I. ARGUMENTS FOR THE ST. LAWRENCE PROJECT

In the literature bearing upon the present St. Lawrence project, one finds three principal arguments advanced in its favor. It is contended (1) that it is necessary for the purpose of relieving railway traffic congestion; (2) that it will reduce transportation costs, thereby giving much needed relief to the interior of the country; and (3) that it will lead to the development of vast water power resources. The first argument played an important rôle in the revival of interest in the St. Lawrence deep waterway immediately following the Great War. The following quotation from the conclusions of the International Joint Commission, is a typical phrasing of the railway congestion argument.[2]

> While the commission is conscious of the fact that war conditions had something to do with the dislocation of railway traffic on the United States side of the boundary, and that various other factors must be taken into account, such as the congestion of traffic at certain critical points between the West and the Atlantic seaboard commonly referred to as "bottlenecks," and the abnormal demand for cars at certain times of the year to carry the peak load of the harvest, it is convinced that the fundamental difficulty lies rather in the phenomenal growth of population and industry throughout the middle western and western states, a growth which the railroads have failed to keep pace with.

While this argument has usually been made with reference to conditions in the United States, some have contended that even on the Canadian side the primary

[2] *Report* of the International Joint Commission. St. Lawrence Waterway. Senate Document No. 114, 67th Congress, 2nd Session, 1922, p. 176.

purpose of the waterway is to relieve future railway congestion. The Secretary of the Port Arthur Grain Exchange, for example, is quoted as saying that "the most difficult problem that our country and the United States have to face in the next decade is to make transportation keep pace with production. Production we believe is ready and waiting to jump forward with a bound." [3]

The second argument, namely, that the St. Lawrence deep waterway would lessen the cost of transportation, is presented in two forms. First, it is contended that the traffic actually carried by the waterway will move at lower rates than those prevailing at present. These reductions in freight rates would apply alike to import and export traffic and to shipments of manufactures as well as agricultural products. The significance of a reduction in transportation rates is most commonly illustrated in connection with the export of agricultural products. It is contended that the opening of the waterway would not only reduce the cost of shipping grain by amounts ranging for the most part from seven to twelve cents per bushel, and thus save that much for the American farmer on every bushel exported, but also that this saving in transportation costs would result in a substantial enhancement of the domestic price of all the grain produced in the tributary territory. Estimates of the yearly aggregate benefit to grain producers vary from $240,000,000 to $366,000,000. To quote from the report of the St. Lawrence Commission of the United

[3] *Ibid.*

States, "the values in a single year to the farmers alone would equal the capital cost of the waterway."[4]

The other way in which the St. Lawrence waterway would affect the lowering of transportation charges would be through forcing the railroads between the Middle Western states and the Atlantic seaboard to reduce their rates. There has long been a deep-rooted distrust of the gigantic railway corporations. Whereas waterways belong to all people it is felt that privately-owned railroads, even when subjected to regulation, cannot be depended upon for reasonable rates. Accordingly, it is often urged that the St. Lawrence project would be justified for its effect upon railroad rates even though no considerable traffic should actually move over the waterway itself. The significance of the route—as potential competitor and actual carrier—is set forth by the Great Lakes-St. Lawrence Tidewater Association as follows:[5]

> It brings the Middle West, with its 40,000,000 people, its 70 per cent of agricultural production, its 45 per cent of total wealth, its more than 40 per cent of total production closer in transportation costs to the markets of the world. It reduces the cost of moving freight to and from the Middle West by an estimated $4 per ton.

It is further pointed out that the reduction of transportation rates would lead to the development of new industries and a vast stimulation of the country's economic prosperity. Because of the location of the St.

[4] For an analysis of this argument see Chapter VII.

[5] *Great Lakes-St. Lawrence Ship Channel Facts and Clip Sheet for Editors*, August 7, 1925.

Lawrence waterway it is looked upon as of particular aid in the desired expansion of American foreign trade. As an incidental feature it has sometimes been urged that if the Great Lakes were thus connected with the Atlantic ocean the distressed American merchant marine would find an enlarged sphere of opportunity.

A special phase of the cheaper transportation argument is that the St. Lawrence project is necessary to offset the transportation disadvantages sustained by the interior of the country as a result of the opening of the Panama Canal. The issues involved are such as to merit separate consideration. The Panama Canal did not exert an important influence upon transportation rates until after the close of the war, when it immediately began to have an influence much greater than had ever been anticipated. Our ambitious war shipbuilding program left us with an excessive supply of vessel tonnage, while at the same time the depressed condition of shipping the world over made it practically impossible to find profitable employment for our vessels in competition with those of other nations. As a consequence sharp competition developed in our protected intercoastal trade, and water rates between the Atlantic and Pacific coasts were drastically reduced. Rates on west-bound traffic particularly were reduced to extremely low levels in order to stimulate back haul traffic. During the same period, however, there was a horizontal increase in railroad rates. Thus low water rates and high rail rates appeared to pinch the Middle West from both sides, for the one enabled the shipper along or near the coast to

move his products at a reduced cost, while the other required the payment of higher freight charges from the interior to points of destination on either coast. Mr. Herbert Hoover has shown the situation concretely as follows:[6]

> . . . . before the war for a staple manufacture, New York was 1904 cents (per ton) away from San Francisco, while now it is only 1680 cents away. But Chicago, which was 2610 cents away from the Pacific Coast before the war, is today 2946 cents away. In other words, Chicago has moved 336 cents away from the Pacific Coast while New York has moved 224 cents closer. . . . . A similar calculation will show that in the same period, as ocean rates remain about the same, Chicago has moved 594 cents away from the markets of the Atlantic seaboard and South America. The same ratios apply to the other Midwest points.

Elsewhere Mr. Hoover has observed that "the result of this has been to shrink up what would otherwise have been a normal growth of Midwest industry and commerce and drive it closer to the seaboard."[7]

The arguments thus far presented have had to do with navigation or transportation considerations. A third and distinct argument rests upon the potentialities of the St. Lawrence River as a source of cheap power. The ultimate installed capacity of hydroelectric plants visualized for the St. Lawrence is 4,000,000 to 5,000,000 horsepower, which figure may be compared with 875,000 horsepower ultimately available at Muscle Shoals. Inasmuch as a program of power development

[6] *Address* at Minneapolis, July 20, 1926.

[7] *Address* before the John Ericsson Republican League of Illinois, Chicago, March 9, 1926.

cannot be undertaken prior to a decision as to whether the St. Lawrence is also to be developed for navigation purposes, those interested in the power phase of the problem have deemed it expedient to join with the commercial and agricultural groups in working for a combined navigation and power project.

In addition to economic considerations, sentiment plays an important part in the St. Lawrence waterway project. The imagination of the "land-locked" Middle West has been captivated by the prospect of seeing the flags of all nations unfurled before the breezes of our great inland seas. As one writer puts it:

> There is, indeed, more than immediate economic need behind the Middle Westerner's belief in the St. Lawrence Waterway. There is ambition. Our eternal American ambition to become greater than we are; the ambition of Duluth to grow as big as Milwaukee, of Milwaukee to outstrip Detroit, of Detroit to be a second Chicago—by some magic of water transport, of freedom to the markets of the world. There is pride. The Great Lakes city wants to be able to say: "We take no second place to New York. We too are a seaport town." And there is the fascination of the sea itself, the pathway to the ends of the earth. The Middle Westerner has a vision of the flags of Cuba and Holland and England and the Argentine and Japan coming over his horizon, and of being able to go down to the dock and smell the smells of the Orient.[8]

II. DIVERGENT INTERESTS

Although the project enjoys wide public support, there are some important differences in attitude which merit presentation. In general, American support of the project centers in the Middle West and opposition

[8] Waldron, Webb, *We Explore the Great Lakes,* p. 244.

in a few Eastern cities. In Canada the sectional alignment is more complicated.

The most powerful support for the St. Lawrence project in the United States naturally comes from the interior of the country. The farmers of the Middle West, as has already been pointed out, regard this waterway as an agency for greatly reducing the cost of transporting their products to Eastern and world markets. Middle Western manufacturing and commercial interests also commonly endorse the St. Lawrence waterway—some favoring it as a means of securing raw materials at lower cost, and others as a cheaper route for the transportation of finished products. Some Middle Western manufacturers, however, are more or less apathetic about the St. Lawrence, being interested rather in the Lakes-to-Gulf deep waterway, or in the possibility of securing a reduction in railroad freight rates.

The St. Lawrence also finds considerable support in the New England States and the Pacific Northwest. Among the organizations which have endorsed the project are the following:

Chamber of Commerce of the United States
The American Bankers' Association
Associated Industries of Massachusetts
National Association of Real Estate Boards
American Farm Bureau Federation
American National Livestock Association
United States Grain Dealers' Association
The Great Lakes Ports Association
National Hardware Manufacturers' Association
Lake Erie and Ohio River Canal Board
West Coast Lumbermen's Association

Opposition to the St. Lawrence project in the United States centers in Eastern cities, chiefly in New York, Buffalo, Baltimore, and Philadelphia. Buffalo is concerned in maintaining her strategic position in the grain trade. More than half the grain sent forward from the upper lake ports is consigned to elevators in Buffalo whose milling industry is second only to that of Minneapolis. Buffalo's elevator capacity is 41 million bushels, treble that of any other lower lake port or seaboard city. In addition to her reserve stock in elevators, storage grain afloat at the end of the lake season (in lake boats tied up at Buffalo for the winter) will average 25 million bushels. Out of a total lake movement of 515 million bushels in 1927, Buffalo received 259 million bushels. The construction of a deep waterway is construed by Buffalo interests as a serious threat to the future welfare of the city.[9]

New York and other seaboard cities oppose the project for various reasons. In the first place, they naturally oppose any diversion of traffic to Canadian ports. The economic history of these Eastern cities is a long record of struggle for controlling trade and development. New York, with Buffalo, has opposed the improvement of the St. Lawrence whenever it has been proposed, while at the same time carrying on a fight with its neighbors—Boston, Philadelphia, and Baltimore—first for

[9] With the St. Lawrence route in successful operation, Buffalo would be slightly off the line of traffic, whether ocean vessels penetrated to the Lakes or lake vessels carried products down to Montreal for transshipment there. The new Welland Ship Canal, as a matter of fact, is likely to have something of the same effect.

supremacy and then against the insistent efforts of these ports to retain an important share of the nation's foreign commerce. These cities are united, however, in their persistent efforts to prevent diversion of traffic through Canadian ports.

The New York Barge Canal is a second factor in the situation. Since 1905 this enterprise has cost the state some $230,000,000 and yet the benefits anticipated, when its enlargement—at an *estimated* cost of $101,000,000—was decided upon in 1903, have in no sense been realized. The admitted failure of the project creates strong doubts in the minds of those who have followed the experiment as to the practicability of any other large inland waterway projects, while on the other hand the construction of a rival water route would effectively extinguish any hope that there may be of the state's salvaging even a part of its outlay on the barge canal.

Accordingly, New York interests contend that if a deep water route from lakes-to-ocean is to be constructed it should utilize the Barge Canal route from Oswego, on Lake Ontario, to a point above Albany and thence down the Hudson to New York harbor. A short canal around Niagara Falls within United States territory would complete this as an All-American route. However, successive reports by the United States Army Engineers, the latest dated December, 1926, point out that the cost of constructing such a route would be much greater than the cost of the St. Lawrence, and they therefore endorse the latter alternative.

On the Canadian side, the International Joint Commission found that "anything like general approval of the undertaking was confined to the Province of Ontario." Toronto and Hamilton, like Chicago and Detroit, wish to become ocean ports and to handle a part of the Canadian import and export trade, which now breaks cargo at Montreal. Likewise, Fort William and Port Arthur anticipate a more flourishing export trade in grain, and hope for a share of the general commerce which is expected to develop between the prairie provinces and overseas markets. Only in that section of Ontario which borders along the Ottawa River is enthusiasm for the St. Lawrence development lacking. This section expects to benefit by the construction of a Georgian Bay Canal, a deep water channel via the French and Ottawa Rivers to Montreal. The deepening of the St. Lawrence would, of course, sound the knell of this long discussed project, which still has its staunch supporters.

In Manitoba and Saskatchewan there is general indifference to the St. Lawrence project. Indeed, in certain sections there is open hostility to it, notwithstanding the enormous grain exports from these provinces. The explanation of this difference in attitude between the grain producers of middle western Canada and the United States is found in the proposed Hudson Bay route to Europe, which for a generation has been held up to the Canadian middle west as the logical outlet for grain and livestock.

The Hudson Bay route calls for the completion of the Hudson Bay Railroad, and for the development of Fort Churchill as a grain exporting point. (See map on page 192.) When completed the Hudson Bay Railroad will extend from Le Pas, a branch terminus of the Canadian National Railroad on the Saskatchewan River 50 miles northwest of Lake Winnipeg, to Fort Churchill on the Hudson Bay, a distance of a little over 500 miles. From Fort Churchill traffic would move by boat to British or Continental ports, via Hudson Bay, Hudson Strait, and a northern steamer route across the Atlantic. The distance via the Hudson Bay route from the heart of the grain-growing area to Liverpool is approximately 1,000 miles shorter than the all-water route via the Great Lakes and the Atlantic; [10] but the route has the disadvantage that the season of navigation for the Bay and Straits is only from 10 to 15 weeks, and ice would always be found in the Straits.

The western provinces look to the Pacific as the natural outlet for their export grain. Grain shipments out of Vancouver vary markedly from year to year. In 1924 a peak of 60,800,000 bushels was reached; in 1925 the amount was only 27,100,000; but in 1928 it reached a new record of 94,200,000 bushels. Shipments to the United Kingdom in this year amounted to 49,500,000 bushels. Alberta is, therefore, no longer

[10] The steaming distance from Fort Churchhill to Liverpool is 3,460 miles. The all-water route from Fort William to Liverpool is 4,422 miles. The rail haul from the heart of the grain area to Fort Churchill would be 700 miles; the rail haul from the wheat fields to Fort William would be fully as great.

vitally interested in either the St. Lawrence or the Hudson Bay route but is more concerned in securing lower rail rates to Pacific ports.

In Eastern Canada opposition to the project comes from two sources. The first consists of commercial, railway, and port interests at Montreal who stand to lose by any lessening of the importance of that city as a transportation terminus. The second consists of those interested in the hydroelectric power development.

Private power interests, both in Quebec and Ontario, oppose the creation of vast amounts of competitive power along the St. Lawrence River. They allege that power now exists in this region in excess of all present requirements and that when additional power is needed it can be obtained elsewhere at a very much lower cost than by the project under consideration. The Hydro-Electric Power Commission of Ontario, foreseeing a future need for more power in that province, expresses itself as not unfavorable to the future development of water power in the International section of the St. Lawrence; but it is fearful of the power users being saddled with the cost of constructing and operating a deep waterway mainly intended for navigation.

III. HISTORY AND PRESENT STATUS OF THE PROJECT

Agitation for the present St. Lawrence project originated in the United States immediately after the Great War. The sudden expansion of grain shipments to Europe led to an increasing use of all transportation

routes, including the St. Lawrence River with its old 14-foot canals. Strains which were being placed upon the railways, in general, together with this increase in river traffic, brought the question of a deep waterway once more before the American public. The Great Lakes-St. Lawrence Tidewater Association, composed now of 22 member states, was formed in 1919 to push the project. In the same year passage of an amendment to the Rivers and Harbors Act was secured, expressing a desire that the International Joint Commission should investigate "what further improvements of the St. Lawrence between Montreal and Lake Ontario are necessary to make the river navigable for ocean-going vessels, together with the estimated cost thereof."

In the intervening years a number of official investigations have been made by Canada and the United States, and the project has been the subject of diplomatic correspondence. The commissions, in the order of their reporting, are: (1) The International Joint Commission; (2) The Joint Board of Engineers; (3) The St. Lawrence Commission; and (4) The Canadian National Advisory Committee. An outline of the problems brought out by the reports of these various commissions, and by the exchange of notes between the two governments, is necessary to an understanding of the present status of the movement.

A. The International Joint Commission

In 1920 the feasibility of improving the St. Lawrence for deep draft vessels was referred to this com-

mission by the governments of the United States and Canada.[11] The commission was asked to report on improvements necessary (1) for navigation interests alone, and (2) for the combination of navigation and power interests "to obtain the greatest beneficial use of the waters of the river." Other questions submitted to the Commission included the extent to which the improvement would develop the resources, commerce, and industry of each country, the nature and volume of incoming and outgoing traffic, the basis upon which the cost should be apportioned to each country, and the methods of administration and control. To assist the International Joint Commission, a board of engineers was created by the two governments to submit plans for the development of a deep waterway together with an estimated cost thereof. After visiting 36 cities and holding extended hearings between March, 1920, and November, 1921, and receiving the report of the engineers,[12] this Commission submitted a report in December, 1921, recommending the improvement of the river.[13] The main conclusions reached are briefly summarized as follows:

(1) The Commission found that "the consensus of opinion in the two countries as revealed at the public hearings, while

[11] In accordance with provisions of a treaty signed by Canada and the United States in 1909, the International Joint Commission was created (1911) as a permanent commission to deal with the use, obstruction or diversion of boundary waters.

[12] *Report* of the United States and Canadian Government engineers, St. Lawrence Waterway, Senate Document No. 179, 67th Congress, 2nd Session, 1922.

[13] *Report* of the International Joint Commission, St. Lawrence Waterway, Senate Document No. 114, 67th Congress, 2nd Session, 1922.

far from unanimous, was on the whole distinctly favorable to the proposed improvement of the St. Lawrence.[14]

(2) The Commission found "that, without considering the probability of new traffic created by the opening of a water route to the seaboard, there exists today, between the regions economically tributary to the Great Lakes and overseas points as well as between the same region and the Atlantic and Pacific seaboards, a volume of outbound and inbound trade that might reasonably be expected to seek this route sufficient to justify the expense involved in its improvement."

(3) The Commission approved a depth of water of 25 feet in the reaches of the canals and 30 feet on the sill of the locks; such depths to be obtained by means of a combination of dams and side canals with locks in the international section and side canals with locks in the national section.

(4) The estimated cost of improvements recommended was placed at 252 million dollars.

(5) Finally, as a preliminary step to the adoption of any definite plan for the development of the river, the Commission recommended a further investigation and review of the engineering aspects of the project by a specially created technical board.

No official action was taken pursuant to the recommendations of the International Joint Commission. But in 1924 the two other commissions referred to above were appointed. The St. Lawrence Commission was appointed by President Coolidge, under the chairmanship of Secretary Hoover, to advise the United States on the economic feasibility of the proposed deep waterway. The National Advisory Committee was appointed by Canada to report to the Dominion government. And, a Joint Board of Engineers on the St. Lawrence water-

[14] The Commission, however, pointed out that "on the Canadian side, anything like general approval of the undertaking was confined to the Province of Ontario. In the other provinces, public sentiment appeared to be either indifferent or more or less hostile."

way project, consisting of three Americans and three Canadians, was appointed to review the engineering report of 1921 and consider certain further questions submitted to it.

B. The Joint Board of Engineers

This Board agreed on the whole with the earlier Joint Board as to the engineering feasibility of the project.[15] They did not, however, reach an agreement as to the plan of improvement which should be adopted for the International Rapids section of the river. The United States engineers recommended the improvement of this section by means of a single stage development, while the Canadian engineers favored a two-stage development.

The Joint Board estimated the total cost of improving the St. Lawrence between Ontario and Montreal at 625 to 650 million dollars—for a 25-foot channel and fully developed power resources. In addition, the cost of improving the restricted Great Lakes channels to a depth of 25 feet was estimated at 45 million dollars. The Welland Ship Canal is estimated to cost 115 million dollars. The improvements which are recommended for immediate development, namely, the creation of a navigation channel and the construction of power plants in the International Rapids section of the river, with an installed capacity of approximately 25 per cent of the ultimate possible development, are estimated to cost from 350 to 385 millions.[16]

[15] *Report* of the Joint Board of Engineers, St. Lawrence Waterway, 1927.

[16] For a full discussion of the cost of the route, see Chapter V.

Among the new questions submitted to this Board for consideration were the desirable depth of channel and the effects of the proposed improvement of the St. Lawrence upon the control of lake levels. As to the desirable depth, the board did not reach an agreement, the United States engineers recommending 25 feet and the Canadians 27 feet. With regard to the control of lake levels, the Commission expressed the opinion that compensating works are practicable, and submitted an estimate of the cost thereof. The Commission further submitted as a finding of fact, that the low lake levels of recent years are primarily the result of low rainfall rather than of diversions through artificial channels.

C. The St. Lawrence Commission

As an aid to this Commission, the Department of Commerce undertook an economic survey of the comparative merits and probable costs of the St. Lawrence deep waterway, the Great Lakes-Hudson project, and the proposed all-American route.[17] Following the completion of this study[18] and the submission of the report of the Joint Board of Engineers, the St. Lawrence Commission made its report late in 1926. This report fav-

[17] The Great Lakes-Hudson route calls for the construction of a ship canal from Oswego on Lake Ontario to the Hudson River. (An alternative route would be via the St. Lawrence River to Lake St. Francis, thence to Lake Champlain, thence to the Hudson.) The all-American route would begin with a canal around Niagara on American territory and then follow the Oswego to Hudson River route.

[18] U. S. Department of Commerce, *Great Lakes-to-Ocean-Waterways,* Domestic Commerce Series, No. 4, 1927.

ored the immediate improvement of the St. Lawrence for navigation and power purposes, provided a suitable agreement could be made with Canada for the joint undertaking.[19]

With reference to the alternative routes, the Commission estimated that the cost of navigation either by the Great Lakes-Hudson route or the all-American route would be much greater than by the St. Lawrence route.

The Commission considered New York State's interest in power development and recommended that "the United States should recognize the proper relation of New York to the power development in the international section."

The Commission stressed the significance of the St. Lawrence route from the transportation point of view, particularly as a relief measure for agriculture. The opinion was expressed that the ship canal would lessen the economic handicap of adverse transportation costs to a vast area in the interior of the continent, including a large part of Canada.

The Department of State transmitted the conclusions of the St. Lawrence Commission to the Canadian Government on April 13, 1927, and expressed the desire of the United States to enter into negotiations for the development of the project. But the Dominion government asked a postponement of further discussion until after the completion and release of the appendices to

[19] *Report* of Chairman of United States St. Lawrence Commission, St. Lawrence Waterway Project, Senate Document No. 183, 69th Congress, 2nd Session, 1927. This document includes the joint engineers' report.

the joint engineers' report, studies which were at that time unfinished.

D. The Canadian National Advisory Committee

The findings of the National Advisory Committee and the views of the Dominion government on the waterway project in general were transmitted to the Department of State in a communication of January 31, 1928.[20] This note was devoted to two purposes, namely, a statement of the conditions under which the Canadian government would be in a position to enter into negotiations with a view to formulating a treaty for the development of the St. Lawrence, and to an exposition of certain factors which distinguish Canada's transportation problem sharply from that of the United States. The items included under the second head may be summarized as follows:

1. Canada's rail transportation facilities have been developed in advance of her needs.
2. Railway rates in Canada are generally lower than they are in the United States. Accordingly, there is a much greater probability of a substantial reduction in transportation costs via the St. Lawrence for United States shippers than there is for Canadian shippers.
3. "As the greater part of Canada's railway mileage is now owned and operated by the State, the St. Lawrence proposals, in so far as they may possibly affect the revenues of the railways, present considerations as to which Canada's point of view is necessarily somewhat different from that of the United States."

[20] For the text of this correspondence, see Appendix A. For the text of the Canadian Committee report, and views of minority, see *St. Lawrence Waterway Project*, Government Printer, Ottawa, 1928.

In answer to the State Department's invitation to enter into an immediate agreement for the improvement of the St. Lawrence, the Dominion government expressed the view that negotiations would be premature at this time. As the situation appears to Canada, two related problems should be disposed of first. The case pending before the Supreme Court of Canada relative to the water power rights of the Dominion government and of the Provinces should be settled,[21] and the engineers of the two countries should reach an agreement on the project to be adopted for the improvement of the international rapids section of the river. In connection with the second point the Canadian government states that:[22]

> It is also considered advisable that opportunity should be afforded for further conference on these alternative proposals between the Canadian section of the Joint Board and engineers representing the Province of Ontario, who have themselves formulated plans dealing with the international section.

With these issues settled Canada expressed herself as ready to coöperate with the United States on a deep waterway project (1) provided a plan can be devised which will not develop Canada's share of hydroelectric power in advance of the growth of her market to absorb it, and (2) provided the Dominion government is not required to undertake heavy financial burdens for the project.

[21] For a statement of the issues involved in this case see Dominion of Canada, *Order in Council P. C. 592,* April, 1928.

[22] Note of January 31, 1928.

Notes exchanged since the Canadian note of January, 1928, need not be discussed in detail.[23] In general the United States is urging action on the St. Lawrence project on the grounds that further investigations and questions at issue can be disposed of concurrently with the drawing of a treaty, while Canada continues to hold the view that a satisfactory solution of certain outstanding problems is a necessary preliminary to preparing a treaty. Thus matters stand at the present time.

[23] For texts thereof see Appendix A.

CHAPTER II

THE NAVIGATION PROJECT

The Great Lakes-St. Lawrence system consists of three divisions: the lakes and connecting channels, the St. Lawrence River from Lake Ontario to Montreal, and the St. Lawrence River Ship Channel from Montreal to the Gulf. The limiting depth in the channels connecting the upper and lower lakes is normally about 20 feet, though lack of water in recent years has at times reduced this depth to as low as 18 feet. Between Port Colborne, at the upper end of the Welland Canal, and Montreal, 14-foot canals afford navigation around the rapids. When the new Welland Ship Canal is completed, a 27-foot channel will connect Lake Ontario and Lake Erie in place of the present 14-foot canal. Below Montreal for a distance of 330 miles to Father Point the St. Lawrence River has been canalized to a depth of 30 feet, and this reach is now being deepened to 35 feet. Below Father Point, as the river widens out into the Gulf of St. Lawrence, navigation is unrestricted. The project under consideration by the Canadian and American governments calls for a deepening of the channel of the upper St. Lawrence between Montreal and the Lakes; and a deepening of the lake and interconnecting channels to a similar depth.

This chapter is devoted to a description of the navigation features of the project. No attempt will be made to appraise the significance of the proposed develop-

ment. The purpose is merely (1) to outline the navigation project, and (2) to show the comparative distances from lake cities to foreign ports by the St. Lawrence all-water route and by alternative rail and water routes.[1]

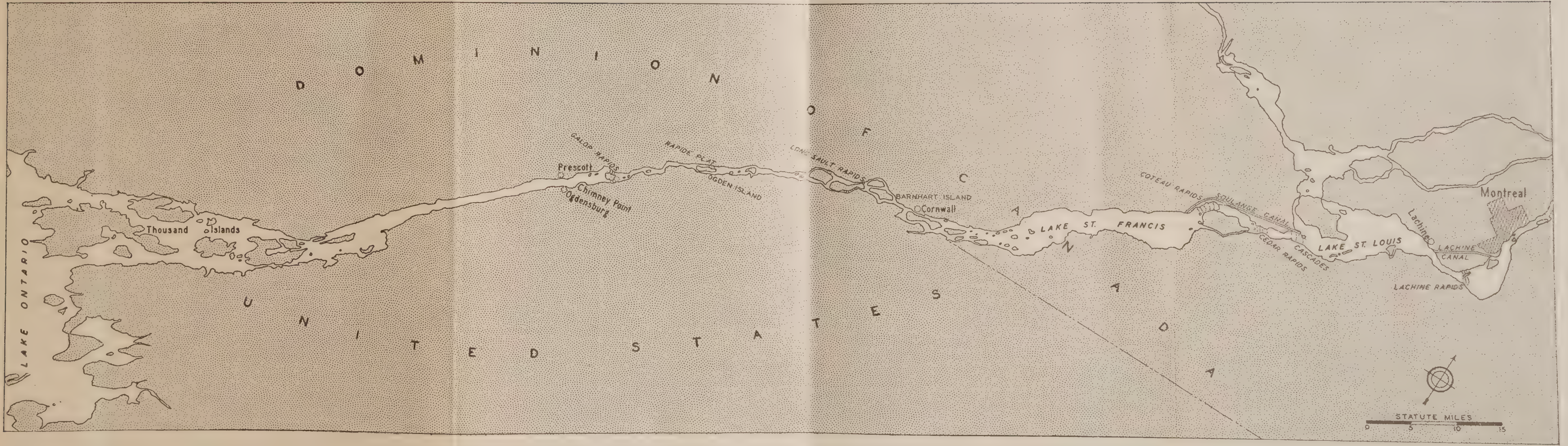
I. DESCRIPTION OF THE PROJECT

As the attached map indicates, the St. Lawrence River between Lake Ontario and Montreal is naturally divided into five sections. In order, downstream, they are as follows: (1) The Thousand Islands section, embracing the deep lake-like reaches of the river, 67 miles in length, from Lake Ontario to Chimney Point, three miles below Ogdensburg, N. Y., and Prescott, Ontario; (2) the International Rapids section, covering 48 miles of rapids and swift water between Chimney Point and the head of Lake St. Francis; (3) Lake St. Francis, 26 miles in length; (4) the Soulanges section, extending from deep water in Lake St. Francis through 18 miles of rapids to deep water in Lake St. Louis; (5) the Lachine section, including Lake St. Louis and the rapids and shoals from this lake to Montreal Harbor, a distance of 23 miles.

It will be seen that the first two sections are along the international boundary between the Province of Ontario and the State of New York. The major improvements that are required are in the second, fourth, and fifth sections. The navigation route will follow the bed of the river except for the Soulanges and Lachine canals and a very short side channel just above Cornwall.

[1] For a description and discussion of the power phases of the project see Chapter X and Appendix K.

St. Lawrence River, Lake Ontario to Montreal



Recognizing the "fundamental principle" that "the interests of navigation on the St. Lawrence are paramount," "the Board has visualized the fullest ultimate development of the navigable capacity of the waterway commensurate with the cost. The endeavor has been made to provide the maximum amount of open river navigation, with a minimum of locks and of canal navigation."[2] The plans developed call for not more than 25 miles of canal navigation, with eight or nine locks, in various stretches between Montreal Harbor and Lake Ontario. The route will be crossed by eight bridges. Channels for navigation are planned with a minimum width of 450 feet, except in canal sections, where they have a bottom width of 200 feet. Open channels are widened where desirable on account of cross currents or bends. The minimum radius of curvature for channels is 5,000 feet. The locks conform in dimensions with those of the new Welland Ship Canal. They have chambers 859 feet in length between the inner quoin posts, and 766 feet between breast wall and fender. Their clear width is 80 feet, and the depth over the sills is 30 feet.

Vessels making the journey from Montreal to upper lake ports will have to pass through the eight or nine locks in the river between Montreal Harbor and Lake Ontario and seven lift locks in the 25-mile channel of the Welland Canal. Boats proceeding to Lake Superior must also pass through the lock at St. Mary's Falls at Sault Ste. Marie. Normally, then, 50 miles of canal

[2] *Report* of Joint Board of Engineers, paragraphs 109, 110.

navigation (25 in the St. Lawrence and 25 in the Welland) and from 15 to 17 lockages would be involved for vessels using the St. Lawrence route.

The distance from Chicago to Montreal is 1,244 miles. Of this total approximately 296 miles are in restricted channels and canals—183 miles in the St. Lawrence River; 25 miles in the Welland canal; 31 miles in the Detroit River; 41 miles in the St. Clair River; and 17 miles in Lake St. Clair. This leaves about 947 miles of open water navigation between the two cities. Vessels sailing to ports on Lake Superior must also pass through the St. Mary's River and the Sault Ste. Marie Canal, a distance of from 63 to 75 miles according to the route taken.

DISTANCES BETWEEN POINTS ON GREAT LAKES AND MONTREAL [a]

(In statute miles)

Ports	Montreal	Kingston	Toronto	Port Colborne	Buffalo	Cleveland	Toledo	Detroit	Collingwood	Chicago
Port Arthur and Fort William	1,215	1,038	904	848	864	711	658	604	531	686
Duluth	1,337	1,160	1,026	970	986	833	781	726	653	808
Sault Ste. Marie	943	765	631	575	592	438	385	331	259	414
Milwaukee	1,179	1,002	867	812	828	675	622	568	505	85
Chicago	1,244	1,067	933	877	893	740	688	633	570	...
Montreal	.....	182	338	368	390	528	605	612	931	...
Kingston	.....	.....	161	191	213	351	427	435	754	...

[a] U. S. War Department, Corps of Engineers, *Survey of Northern and Northwestern Lakes*, Bulletin No. 35, April, 1926, p. 8.

The table on page 28 shows the distances between various cities on the St. Lawrence-Great Lakes route. The frontispiece map shows the Great Lakes and the St. Lawrence river, with the principal ports and terminals along the route.

II. COMPARISON OF PRESENT ROUTES AND THE PROPOSED ROUTE

The distance advantage between lake cities and western European ports via the St. Lawrence River compared with the lake and rail route via Buffalo and New York is indicated by the map on page 30. It is of interest to observe that the leading seaports of western Europe are located much further north than the corresponding ports on the American seaboard; hence the St. Lawrence River, which flows in a northeasterly direction, is almost in a direct line with the European ports. To many people it may come as a surprise to find that the most direct route from Pittsburgh to Liverpool is by Cleveland and Montreal rather than by New York. This fact is obscured by the ordinary Mercator projection map on which distances from east to west and south to north are increasingly exaggerated as one goes further from the equator.[3] The map shown on page 30, which is a conic projection, gives a true comparison of the actual distances between various points.

The distance between Montreal and Liverpool is 3,207 miles, computed on the route through the Straits

[3] For example, on a Mercator projection Greenland appears larger than South America, while in reality it is only one-ninth the size of South America.

Distances: Lake Ports to Europe, by Alternative Routes

of Belle Isle. This route, however, cannot be used until June of each year, the route south of Newfoundland being followed for the earlier months. The southern route is approximately 170 miles longer, or a total of 3,377 miles. The distance between New York and Liverpool over the winter eastbound route is 3,578 miles; over the summer eastbound route 3,707 miles. The saving in distance via the St. Lawrence thus varies somewhat with the season of the year, but averages about 350 miles. To Plymouth or Southampton the saving in distance is about one-half that on the New York-Liverpool route, and the same is true of voyages to Antwerp, Rotterdam, and Hamburg.

The table on page 32 shows the savings in distance to Liverpool from seven lake cities by the all-water route via Montreal as compared with the lake and rail route via Buffalo and New York and by the all-rail route to New York.

It will be observed that in all but one case there is a considerable saving in mileage via the St. Lawrence route compared with either the combination lake-and-rail route to New York or the all-rail route to New York. The distance from Chicago to Liverpool is only 36 miles greater via rail to New York than by the St. Lawrence route. The relative distances from lake ports to Glasgow and London are practically the same as to Liverpool.

To the French and Mediterranean ports there is, however, no distance advantage via the St. Lawrence route. The ocean voyages from Montreal to Gibraltar and from New York to Gibraltar are of about equal length; hence

COMPARATIVE DISTANCES, LAKE PORTS TO LIVERPOOL [a]

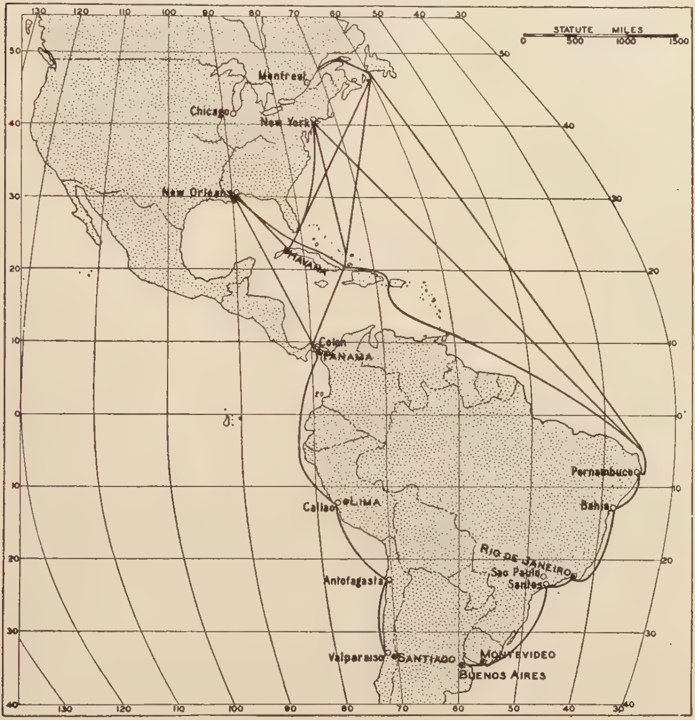
(In statute miles)

Lake Ports	Lake and Rail via Buffalo and New York				Rail-Water via New York			All-Water via Montreal	Saving All-Water over Rail-Water
	Lake	Rail	Ocean	Total	Rail	Ocean	Total		
Duluth	986	396	3,578	4,960	1,277	3,578	4,855	4,544	311
Chicago	893	396	3,578	4,867	909	3,578	4,487	4,451	36
Detroit	261	396	3,578	4,235	648	3,578	4,226	3,819	407
Toledo	254	396	3,578	4,228	701	3,578	4,279	3,812	467
Cleveland	176	396	3,578	4,150	579	3,578	4,157	3,735	422
Buffalo	0	396	3,578	3,974	396	3,578	3,974	3,597	377
Port Arthur	864	396	3,578	4,838	1,358	3,578	4,936	4,422	514

[a] Compiled from U. S. War Department, Corps of Engineers, *Survey of Northern and Northwestern Lakes*, Bulletin No. 35, April, 1926, p. 8; U. S. War Department, *Official Table of Distances*; and U. S. Hydrographic Office, *Table of Distances Between Ports*, H. O., No. 117, 1928.

comparison between the two routes turns on the difference in mileage between the all-water route to Montreal and the all-rail or lake and rail route to New York.

DISTANCES LAKE PORTS TO SOUTH AMERICA, BY ALTERNATIVE ROUTES



From the Middle West to the West Indies and to South America, the St. Lawrence route is at a substantial distance disadvantage as compared with routes both via north Atlantic and Gulf ports. The map on this page affords a rough indication of relative distances. It will

be observed that distances to the West Indies and South America are much greater as shown on an "equal area" map than they appear to be from an ordinary Mercator projection. For example, the distance from Montreal to New York is greater than the distance from New York to Havana—1,680 miles as compared with 1,413 miles. The distance from Chicago to Havana via the St. Lawrence is 4,091 miles, via New York 2,322 miles, and by New Orleans 1,624 miles. The distance from Chicago to Rio de Janeiro is 7,412 miles by the St. Lawrence, 6,402 miles by New York, and 6,895 by New Orleans.

This brief survey of distances shows that the St. Lawrence route possesses some advantages as between the Middle West and northern Europe, that it is practically on a parity with the New York route to Gibraltar, and that it is at a substantial disadvantage in connection with trade in the West Indies and South America. The reader will, of course, bear in mind that distance is only one element affecting the cost of transportation and the determination of the route by which shipments will go. Such factors as speed, the amount of cargo offered, the probability of cargo both ways, port charges, loading and discharging expenses, etc., are often of great importance.

CHAPTER III

THE DEPTH OF CHANNEL REQUIRED

Three different depths of channel have been suggested for the proposed St. Lawrence route, namely, 25 feet, 27 feet, and 30 feet. No final conclusion has, however, been reached as to which of these depths is desirable. The majority of the Canadian section of the Joint Board of Engineers favored an initial depth of 27 feet, which is the depth of the new Welland canal. But a majority of the United States section regarded an initial depth of 25 feet as sufficient, on the ground that "a project for a greater depth through the inter-lake channels above Lake Erie is not foreseen for a long period."[1] On the other hand, the survey of the economic aspects of the proposed route made by the United States Department of Commerce reaches the conclusion that in order to secure proper ocean connection the minimum depth of channel should be 27 feet. There is general agreement that permanent structures, such as locks, should be given a minimum depth of 30 feet so as to render it possible by subsequent deepening of the canals to provide for vessels of even greater draft.

[1] *Report* of Joint Board of Engineers, December 6, 1926, Section III.

I. THE 25-FOOT PROJECT

In considering this alternative we must take into account (1) the draft of vessels that could navigate a 25-foot channel, and (2) the percentage of present ocean shipping that could use the route.

It is important to note that a 25-foot channel would permit the passage of vessels with a salt water draft, fully loaded, of not more than 22 feet. In popular discussion, the fact is commonly ignored that there must be a considerable depth of water between the keel of the ship and the bed of the channel to permit safe navigation. The "squat" of the vessel is affected by turning in bends of the channel, by speed, and by winds and current. Authorities differ somewhat as to the margin of safety normally required. To obtain the Port Warden's sailing permit, vessels leaving Montreal to pass down the St. Lawrence are required to have a 2 foot 6 inch clearance beneath the keel in the existing water stage. Practical navigators with whom we have consulted assure us that this is a minimum allowance.[2]

It would seem to follow from this, at first thought, that a 25-foot St. Lawrence-Great Lakes channel would permit the passage of ocean vessels listed as having a

[2] In the literature that is being circulated in support of the project, such inaccurate statements as the following are not infrequently made: "A 30-foot channel through the 33 miles of canal involved in the St. Lawrence development will permit free navigation for vessels loaded to 29 feet. The combination passenger and freight vessels now plying to Montreal have no more than this [that is, one foot of water] under their keels at low water." Charles P. Craig, Executive Director of the Great Lakes-St. Lawrence Tidewater Association in a letter to the *Washington Post*, July 27, 1925.

loaded draft of 22 feet, 6 inches. Such is not, however, the case, for the reason that ships have a greater displacement in fresh than in salt water, owing to the greater density of the latter.[3] For example, a vessel which has a salt water draft of 22 feet, 6 inches would actually draw about 23 feet in fresh water. Thus a 25-foot channel would permit the navigation of ocean vessels, fully loaded, with a salt water draft of only 22 feet, or a fresh water draft of 22 feet, 6 inches; a 27-foot channel would permit the passage of ocean vessels with a salt water draft of about 24 feet or a fresh water draft of 24 feet, 6 inches; and a 30-foot channel would permit the entrance to the Lakes of vessels with a draft of slightly less than 27 feet salt water, or 27 feet, 6 inches fresh water. A depth of 33 feet would permit the passage of loaded vessels with a salt water draft of only about 29 feet, 9 inches.

While an allowance of a minimum of three feet between the loaded draft, salt water, of a vessel and the depth of the channel is thus required, we have not in the computations below allowed for a spread of a full three feet. We have used 2 feet, 6 inches instead, and this for two reasons. First, the data available happen to be grouped so as to show the number of vessels drawing 22 feet, 6 inches; 23 feet, 6 inches, etc., rather than 22 feet, 23 feet, etc. Second, it may be argued that vessels would leave the Lakes with only a part of their bunker supplies, and fuel a second time at Montreal,

[3] The weight of a cubic foot of fresh water is 1,000 ounces; of the densest sea water on the British coast 1025 ounces. *Lloyd's Register of Shipping,* 1925-1926, Vol. II, p. 510.

thus maintaining the minimum clearance of 2 feet, 6 inches by running a little light through the canals.

A 25-foot channel would exclude all important ocean shipping. All steam and motor cargo vessels employed in carrying the foreign trade of the United States, during the calendar year 1926, are classified in the following table in such a way as to show the percentage of the total that could navigate a 25-foot channel. Since the vessels included represent practically all nations, the table gives a fair picture of the general character of world freight tonnage.

CARGO SHIPS CARRYING U. S. FOREIGN TRADE, 1926

Classified by Draft Groups with Reference to a 25-foot Channel [a]

Draft	Vessels in Each Class		Aggregate Tonnage in Each Class	
	Number	As Percentage of Total	In Gross Tons	As Percentage of Total
22′ 6″ or under	608	19.5	1,751,378	11.5
Over 22′ 6″....	2,495	80.5	13,460,356	88.5
Total.....	3,103	100.0	15,211,734	100.0

[a] Exclusive of tankers. Compiled from unpublished data (excluding ships engaged in the Caribbean trade) supplied by the Bureau of Research, U. S. Shipping Board. For cargo-passenger vessels, see page 43.

With a limiting salt water draft of 22 feet, 6 inches, the St. Lawrence route would be restricted to about 20 per cent of the cargo vessels engaged in American foreign trade. In terms of tonnage only 12 per cent of

these ships could be accommodated by a 25-foot project. Only the coastwise ships and small inefficient ocean vessels could enter the Lakes over such a channel.[4]

Even though a 25-foot channel would not permit any considerable number of ocean vessels to enter the Lakes, might not such a route nevertheless be justified on one or another of the following grounds? First: Might not the lake vessels pass over this route and themselves carry cargoes to the markets of the world? Second: Might not a special type of shallow draft vessel be constructed for lake and ocean navigation? Each of these possibilities must be briefly considered.

Lake vessels could not operate on the high seas, because of technical considerations. The possibility that the lake vessels might engage in the ocean carrying trade has long been considered by engineers. The naval architect, Herbert C. Sadler, of the University of Michigan, states that:[5]

The lake freighters are the last word in a type of vessel especially developed to do the business of carrying bulk commodities, such as iron ore, coal, etc., in the most economical way between the different lake ports. Their business is on the lakes, not on the ocean. . . . To alter the design to allow

[4] Advocates of the 25-foot project have cited as evidence of its adequacy the fact that the average draft of all vessels passing through the Panama Canal is around 22 feet. This average draft of all transits includes, however, not only all of the small, miscellaneous craft but also includes vessels in ballast as well as those loaded. The truth of the matter is that 18.4 per cent of the loaded vessels, exclusive of tankers, passing through the canal in 1926 drew more than 27 feet of water and 61.4 per cent drew more than 24 feet.

[5] *Proceedings* of the American Society of Civil Engineers, October, 1925, p. 1697.

them to go to sea would be suicidal, and almost as absurd as to suggest putting a passenger vessel of the Hudson River Day Line into the North Atlantic trade when the summer excursion season was over.

As Major Thomas W. Symons, of the United States Engineer Corps, pointed out as long ago as 1897:

Ocean vessels, fitted for combating the storms of the North Atlantic, are built much heavier, stronger, deeper, and on finer lines than the lake ships. The machinery differs radically, owing to the salt water, and is more expensive and differently placed. In the ocean ships surface condensers are imperative, and much brass or lead piping is required. The machinery, placed amidships, interferes with rapid loading and unloading. The hatches are too small and too few, and not properly spaced to suit docks, elevators, etc., and the rapid handling of freight in Lake ports. The coal bunkers are too large, occupying valuable room. All deck constructions, the rudder, anchors, chains, etc., are heavier and more expensive than are required for the Lakes. The decks add weight and interfere with loading, storing, and unloading bulky, coarse freight.[6]

The difference between the lake boats designed for the carriage of bulk cargoes and ocean-going vessels of a similar character may be shown from the following illustrations. The 500-foot lake freighter has a 56-foot beam, a 20-foot draft, and a displacement of 13,717 tons;[7] while the sea-going 500-footer has a 64-foot

[6] *Engineering News*, November, 1897, p. 319.

[7] At the present time even longer lake vessels are being built, the "600-footers" constituting the aces of the modern lake fleet. Five such boats were completed in 1925, the three largest being 618 feet in length. The following year added three more "600-footers" to the fleet, including the Lemoyne, with a length of 633 feet and a beam of 70 feet. The year 1927 saw the completion of nine bulk freighters, and eight of these had a length of 600 feet or more. The largest established a new length record of 683 feet. *Annual Report*, Lake Carriers' Association, 1925, 1926, and 1927.

beam, a draft of 28 feet, 5¼ inches, and a displacement of 21,450 tons.[8]

As an illustration of the character of vessel that has been found desirable for the transportation of heavy, bulky commodities on the high seas, we may cite the Bethlehem Steel Corporation's boats which carry iron ore from Chili and Cuba to the Sparrow's Point plant near Baltimore. This company operates nine boats of a deadweight tonnage varying from 10,000 to 20,000, and having a draft as great as 34 feet, 6 inches.

A special type of vessel for lake and ocean navigation is not feasible. After investigating this question, Major Symons wrote in 1897 that: "However carefully a vessel may be designed for service on both lakes and ocean, she must necessarily be a compromise between two widely differing types, and inferior to each on its own water. She can neither carry cargoes on the lakes as cheaply as the lake ships, nor on the ocean as cheaply as the ocean ships."[9] Professor Sadler concurs in this view, stating that: "If changes were made in designs so that they would be a compromise between two different sets of conditions, they would probably be failures in both."[10]

There seems to be agreement among both naval architects and shipping men that the hybrid type of vessel is not feasible and that the economical type of lake freight-

[8] Taylor, Rear Admiral D. W., Thirty-First *Annual Meeting* of the Society of Naval Architects and Marine Engineers, p. 46.

[9] *Engineering News,* November, 1897, p. 318.

[10] *Proceedings* of the American Society of Civil Engineers, October, 1925.

ers is not adapted to navigation on the open ocean. Accordingly, the success of the St. Lawrence deep waterway project must depend upon the possibility and the feasibility of bringing the regular ocean-going vessels into the Great Lakes.

II. THE 27-FOOT PROJECT

It is evident from the foregoing discussion that, if the St. Lawrence waterway is to constitute an important avenue of commerce for ocean-going vessels, the channel must be more than 25 feet in depth. Will a depth of 27 feet, as favored by the Canadian section of the Joint Board of Engineers, and by the Committee of the United States Department of Commerce, prove adequate? Or is perhaps a still greater depth a necessity?

A 27-foot channel would be of practically no value for combination passenger-cargo ships engaged in the overseas trade of the United States. An analysis of the draft of passenger cargo vessels [11] shows that less than 15 per cent of the vessels, representing approximately 5 per cent of the aggregate tonnage, could enter the Great Lakes on a 27-foot channel. The details of the analysis are shown in the table on page 43.

[11] The distinction between freight and passenger-cargo vessels is necessarily an arbitrary one since many freighters are fitted for carrying a few passengers, as an accommodation to the trade. In the data supplied us the United States Shipping Board follows the rule of the United States Steamship Inspection Service which says that any vessel carrying 16 passengers or more shall be considered a combination passenger-cargo vessel.

Passenger-Cargo Ships Carrying U. S. Foreign Trade, 1926

Classified by Draft Groups with Reference to a 27-Foot Channel [a]

Draft	Vessels in Each Class		Aggregate Tonnage in Each Class	
	Number	As Percentage of Total	In Gross Tons	As Percentage of Total
24′ 6″ or under	37	13.4	171,680	5.2
Over 24′ 6″....	240	86.6	3,106,462	94.8
Total.....	277	100.0	3,278,142	100.0

[a] Compiled from unpublished data (excluding ships engaged in the Caribbean trade) supplied by the Bureau of Research, U. S. Shipping Board.

A survey which we have made of the vessels engaged in the passenger-cargo trade between New York, Boston, Baltimore, and North European ports in the month of June, 1928, shows only one vessel which could have made use of the St. Lawrence waterway. This was the Estonia—6,345 gross tons, draft 24 feet—sailing between New York and Baltic ports.[12]

A 27-foot channel would exclude 62 per cent of the tonnage and 85 per cent of the faster cargo vessels now entering American ports. The drafts of all cargo ships, including both liners and tramps (but excluding tankers) entering American ports in 1926, are shown in the table which follows.

[12] For list of vessels operating in the North Atlantic trade, see Appendix B.

CARGO SHIPS CARRYING U. S. FOREIGN TRADE, 1926

Classified by Draft Groups with Reference to a 27-Foot Channel[a]

Draft	Vessels in Each Class		Aggregate Tonnage in Each Class	
	Number	As Percentage of Total	In Gross Tons	As Percentage of Total
24′ 6″ or under	1,514	48.7	5,834,140	38.3
Over 24′ 6″....	1,589	51.3	9,377,594	61.7
Total.....	3,103	100.0	15,211,734	100.0

[a] Exclusive of tankers. Compiled from unpublished data (excluding ships engaged in Caribbean trade) supplied by the Bureau of Research U. S. Shipping Board.

The table on page 45 classifies these same boats on a speed basis. The results indicate an even more limited use of a 27-foot channel, than is shown by the draft classification. Only about 15 per cent of the fast vessels—12 knots and above—could navigate a 27-foot channel, and only a little over 50 per cent of the vessels with a speed of from 10 to 12 knots could traverse a 27-foot channel.

Our survey of vessels engaged in trade between New York, Boston, Baltimore, and North European ports, in the month of June, 1928, shows that only 35 per cent of the cargo liner tonnage could utilize the St. Lawrence route. Of these, two-thirds are the subsidized United States Shipping Board boats which were constructed during the emergency period of the Great War. Most of the remainder that could navigate a 27-foot channel are Scandinavian vessels engaged in trade between

CARGO SHIPS CARRYING U. S. FOREIGN TRADE, 1926

Classified by Speed Groups with Reference to a 27-foot Channel [a]

Speed	Ships with Draft of 24′ 6″ or Under		Ships with Draft over 24′ 6″		Total Ships
	Number	As Percentage of Ships in Speed Group	Number	As Percentage of Ships in Speed Group	
Slow vessels					
Under 9 knots...	74	....	20	....	94
9 knots..........	331	....	97	....	428
9½ knots.......	20	....	38	....	58
Total.......	425	73.2	155	26.8	580
Medium-speed vessels					
10 knots.........	520	....	360	....	880
10½ knots......	140	....	133	....	273
11 knots.........	188	....	282	....	470
11½ knots......	12	....	25	....	37
Total.......	860	51.8	800	49.2	1,660
Fast vessels					
12 knots.........	88	....	394	....	482
12½ knots......	3	....	27	....	30
13 knots.........	15	....	83	....	98
13½ knots......	1	....	13	....	14
14 knots.........	0	....	39	....	39
15 knots.........	0	....	7	....	7
16 knots.........	0	....	13	....	13
17 knots.........	0	....	1	....	1
Total.......	107	15.6	577	84.4	684
All classes [b]...	1,392	....	1,532	....	2,924

[a] Exclusive of tankers. Compiled from unpublished data (excluding ships engaged in Caribbean trade) supplied by the Bureau of Research, U. S. Shipping Board.

[b] 122 vessels of 24 feet 6 inches draft or under and 57 vessels having a draft greater than 24 feet 6 inches are omitted on account of lack of data as to speed.

American and Baltic ports. The only British boats in the list which could navigate the route are two small vessels which ply between United States and Bristol channel ports.[14] The schedule of arrivals at New York in the month of December, 1927, shows that the situation is practically the same in the winter months.[15]

Only 13 per cent of the tonnage now operating on regular schedule out of Montreal and Quebec could navigate a 27-foot channel. For the navigation season of 1926, we have made a tabulation of the loaded drafts (salt water) and gross tonnages of all vessels maintaining regular passenger or freight services between Montreal and other parts of the world. Out of a total of 110 vessels thus employed, 82 vessels, representing 75 per cent of the total number of boats and 87 per cent of the aggregate gross tonnage, had drafts over 24 feet, 6 inches. Only 28 vessels, representing 13 per cent of the total tonnage, had loaded drafts less than 24 feet, 6 inches. Moreover, 11 out of these 28 smaller vessels were subsidized Canadian Government Merchant Marine boats.[16] The number of small boats which maintained regular services out of Montreal on a competitive basis is thus reduced to 17. The results of the tabulation are shown in the table on the following page.

[14] See Appendix B.

[15] See Appendix B.

[16] For the three years 1923-25 the Canadian Government Merchant Marine had an average deficit from operations of $1,417,742. For 1926, the operating deficit was only $90,160; the book deficit, however, which takes into account depreciation and interest charged by the Dominion Government on the wartime cost of the vessels, amounted to $6,687,221. *Annual Reports* of the Canadian Government Merchant Marine, Ltd.

VESSELS MAINTAINING REGULAR SERVICES OUT OF MONTREAL AND QUEBEC

Classified by Draft Groups with Reference to a 27-Foot Channel[a]

Destination	24′ 6″ and under		Over 24′ 6″	
	Number of Boats	Aggregate Gross Tonnage	Number of Boats	Aggregate Gross Tonnage
Great Britain..........	8	31,567	59	541,120
Continental Europe....	9	30,494	6	33,195
South America.........	1	5,070	4	22,422
West Indies...........	6	19,831	1	3,097
Australia and New Zealand............	4	13,825	8	46,550
South Africa...........	....	....	4	28,952
Total.............	28	100,787	82	675,336

[a] Names of vessels obtained from sailing lists issued by the Canadian Pacific Railway and the Canadian National Railways for 1926. Data on gross tonnage compiled from *Lloyd's Register of Shipping.* Drafts of vessels obtained from *Lloyd's Register* and from steamship lines.

A 27-foot channel would exclude 60 per cent of the aggregate net tonnage of Montreal grain tramps. For the four years 1924-1927, Canadian exports of grain moving out through Montreal have varied from 125 million bushels in 1924 to 185 million bushels in 1927. Of the total exports through this port, liners have carried annually about 55 million bushels, and chartered vessels the rest. The table on page 48, covering nearly 90 per cent of the chartered (tramp) vessels engaged in the grain trade[17] in 1927 shows that about 45 per cent of these boats, representing 60 per cent of the net

[17] For a discussion of the meaning of "tramp" vessels see pp. 68-72.

tonnage, could not have navigated when fully loaded a 27-foot channel.

VESSELS CARRYING FULL CARGOES OF GRAIN OUT OF MONTREAL IN 1927

Classified by Draft Groups with Reference to a 27-Foot Channel [a]

Draft	Vessels in Each Class		Aggregate Tonnage in Each Class	
	Number	As Percentage of Total	In Net Tons	As Percentage of Total
24′ 6″ or under	232	55	441,750	40
Over 24′ 6″....	189	45	669,738	60
Total.....	421	100	1,111,488	100

[a] The total number of steamers loading full cargoes in 1927, as reported to us by the Port Warden of Montreal, was 487. The Funch Edye *Weekly Freight Report*, however, on which we are dependent for information as to tonnage, includes only 421 vessels. The drafts of these vessels have been obtained from *Lloyd's Register of Shipping*.

A 27-foot channel would exclude 81 per cent of the cargo vessels and all the tankers engaged in the inter-coastal trade. In the table on page 49 we show a classification by drafts of the vessels, exclusive of tankers, engaged in the trade between Pacific coast ports and North Atlantic coast ports for the first six months of 1928.

A check of the loaded drafts of the first 50 oil tankers passing through the Panama Canal (1928) with cargoes originating at Pacific coast ports and destined to North Atlantic coast ports shows that none of them could navigate a 27-foot channel. The minimum draft for any of these vessels was 25 feet, 6 inches; the average draft for the 50 vessels was 27 feet, 4 inches.

Ships Engaged In The Eastbound Intercoastal Trade, January 1—July 1, 1928

Classified by Draft Groups with Reference to a 27-Foot Channel [a]

Draft	Number	As Percentage of Total
24′ 6″ or under	52	19
Over 24′ 6″	228	81
Total	280	100

[a] Exclusive of tankers. Compiled from *Panama Canal Record.* In classifying the boats the maximum draft recorded at any transit of the canal during the six months was used.

We may now summarize the evidence which has been compiled with reference to the adequacy of a 27-foot channel. It has been established that such a channel would accommodate

(1) Practically none of the combination passenger and cargo vessels now engaged in the overseas trade of the United States;

(2) Only 13 per cent of the tonnage now operating on regular schedules out of Montreal;

(3) About 40 per cent of the tonnage of grain tramps out of Montreal;

(4) About 38 per cent of the tonnage of all cargo boats, including tramps, at present engaged in the overseas trade of the United States, but including only 15 per cent of the vessels having a speed as great as 12 knots.

(5) None of the tankers and only 19 per cent of the cargo vessels engaged in the trade between Atlantic and Pacific coast ports.

In brief, a 27-foot channel limited to vessels drawing less than 24 feet, 6 inches would, broadly speaking, accommodate only boats of the type now engaged in the local coastal trades and the smaller steamers, mainly the war-built United States Shipping Board boats and tramps. Moreover, as we shall presently see, the trend in ocean shipping is steadily toward larger and deeper draft vessels.[18]

[18] In the United States Department of Commerce Bulletin entitled *Great Lakes-to-Ocean Waterways*, E. S. Gregg and A. Lane Cricher reach the following conclusion: "In order to assure a proper ocean connection, the minimum depth of channels should be 27 feet, thus accommodating vessels of 25-foot draft; such draft would include 54 per cent of American cargo vessels (dead weight tonnage) and 88 per cent (dead weight tonnage) of all our entrances and clearances."

The implication of this statement clearly is that a 27-foot channel would be adequate for the purposes which the waterway is intended to accomplish. The analysis leading to this conclusion is, however, misleading rather than convincing. (1) The tabulation includes only American ships; and American tonnage transports only one-third of our import and export trade. (2) It includes only freighters among American vessels engaged in carrying trade. That is to say, the important combination passenger-cargo vessels, which are typically of larger size, are omitted. (3) Of the total of 808 vessels included in the tabulation, 357, or 45 per cent, of the tonnage, are coastwise vessels, which typically have a shallower draft than those engaged in overseas trade. (4) The 88 per cent is based on entrances and clearances. Data for entrances and clearances cover all sorts of small ocean craft including sail boats and sea barges, which are engaged in local commerce along our international boundary. A large fleet of these small boats operates on Puget Sound, handling lumber, coal, sand and gravel, salt and fish. Along the North Atlantic coast of the United States and Canada, lumber, wood pulp, coal and gypsum furnish commerce for various small vessels; and there is a fleet of small boats trading between the Bahama Islands and the South Atlantic and Gulf ports. When the calculation is based upon entrances and clearances, these small boats are given a very heavy weighting because they operate on short turn-arounds and enter or leave our ports more frequently than do the larger trans-oceanic vessels, and often in ballast. (5) Finally, the report assumes that a 27-foot channel would accommodate vessels drawing 25 feet, salt water draft, whereas, as we have seen, 24 feet 6 inches is the maximum.

III. WOULD A DEPTH OF 30 FEET PROVIDE A FIRST-CLASS ROUTE?

In order to answer the question as to the depth of channel that is required if the St. Lawrence waterway is to be a genuinely first-class route for ocean shipping,

SHIPS CARRYING U. S. FOREIGN TRADE, 1926

Classified by Draft Groups with Reference to 30-Foot Channel [a]

I. Passenger-Cargo Vessels

Draft	Vessels in Each Class		Aggregate Tonnage in Each Class	
	Number	As Percentage of Total	In Gross Tons	As Percentage of Total
27′ 6″ or less...	104	37.6	672,858	20.5
27′ 6″ to 30′ 6″.	94	33.9	1,124,860	34.3
30′ 6″ to 33′ 6″.	60	21.7	894,516	27.3
33′ 6″ to 36′ 6″.	12	4.3	326,322	10.0
Over 36′ 6″....	7	2.5	259,586	7.9
Total.....	277	100.0	3,278,142	100.0

II. Cargo Vessels

Draft	Vessels in Each Class		Aggregate Tonnage in Each Class	
	Number	As Percentage of Total	In Gross Tons	As Percentage of Total
27′ 6″ or less..	2,767	89.2	12,690,575	83.4
Over 27′ 6″ up to 30′ 6″....	302	9.7	2,205,638	14.5
Over 30′ 6″ up to 33′ 6″....	34	1.1	315,521	2.1
Total.....	3,103	100.0	15,211,734	100.0

[a] Exclusive of tankers. Compiled from unpublished data (excluding ships engaged in Caribbean trade) supplied by the Bureau of Research, U. S. Shipping Board.

it is necessary, first, to make a further classification of the data with reference to existing tonnage, and, second, to study the trend in ocean shipping. (The figures which follow are derived from the foregoing tables.)

A 30-foot channel would accommodate approximately 38 per cent of the combination passenger-cargo vessels engaged in American foreign trade, representing only 20 per cent of the gross tonnage of this class of vessel. Such a channel would, however, permit the passage of 89 per cent of the cargo vessels representing 83 per cent of the gross tonnage of this class of ships.

Stating the matter the other way around, a 30-foot channel would not accommodate:

First, 173 combination passenger-cargo vessels engaged in the United States foreign trade, representing 80 per cent of the total tonnage of this class.

Second, the cream of the cargo tonnage—336 large freighters—including practically all of the up-to-date refrigerator ships.[19]

Third, the large passenger-cargo vessels and some of the larger freighters engaged in the Montreal trade.[20]

[19] During 1926 there were 45 refrigerator ships engaged in our overseas foreign trade, and of these vessels 33, having speeds of 12 knots or more, could not navigate a 30-foot channel. The 12 vessels adapted to a 30-foot channel included 6 British ships built between 1893 and 1900; 2 Italian ships built in 1900; and one from each of the following countries built between 1911 and 1924; Great Britain, Japan, Italy, and Jugoslavia. Only five of the excluded vessels had speeds of 12 knots or more.

[20] Because of a limiting depth of 30 feet in Montreal Harbor, the larger vessels now dock at Quebec. Work is in progress to make the limiting depth of the St. Lawrence River up to Montreal 35 feet.

Before passing judgment upon the adequacy of a 30-foot channel, it is necessary to consider the trend in the draft of ocean vessels. Inasmuch as the St. Lawrence waterway could not be open to navigation for something like a decade, the draft of ocean vessels in the future is obviously a matter of great importance.

The trend in ocean shipping is toward larger and deeper draft vessels. Despite the tendency during the period of the great war to build somewhat smaller ships, we find that the average size of ocean-going vessels has increased rapidly during the past 15 years. In 1913 the average size of ships engaged in trans-oceanic trade, as shown by clearances in the principal maritime countries, was approximately 5,800 gross tons, while in 1925 it was as high as 7,000 gross tons.[21] This tendency has been particularly marked during the last five years. A development of special interest in this connection has been the recent remarkable increase in the number of motor-driven liners.

By 1925 the world's output of motor vessels had risen, in terms of gross tonnage, to 65 per cent of the output of steam vessels; for the year 1926 it was 76 per cent; while motor tonnage under construction on January 1, 1927, equalled 90 per cent of the steam tonnage then under construction. The motor-driven boats engaged in trans-oceanic trade typically range from 6,000 to 8,000 tons gross, and maintain a sea speed, loaded, of from 12 to

[21] Chamberlain, E. T., "Liner Predominance in Trans-oceanic Shipping," U. S. Department of Commerce *Trade Information Bulletin,* No. 448, p. 3.

16 knots an hour. For example, the recently constructed Prince Line freighters are about 6,250 gross tons and can make a speed of 14 knots, and it is announced that plans are completed for vessels capable of a speed of 16 knots; the new Rotterdam-Lloyd ships are the same size and will have a speed of 14½ knots; and the Shaw, Savill, and Albion boats are approximately 7,000 tons gross and are expected to maintain a speed of more than 15 knots an hour.

The motor-driven boats show considerable variation in draft. The larger of these vessels have a draft well beyond 27 feet at the present time. For example, the five new Prince Line vessels are 27 feet, 6⅜ inches; the four new Netherland Steamship Line vessels are 28 feet, 7 inches; the four new Shaw, Savill, and Albion boats are 28 feet, 10 inches; two of the new Hamburg-American Line motor vessels are 29 feet; the three new Commonwealth and Dominion Line boats have a draft of 29 feet, 1 inch; and the Sun Shipbuilding and Dry Dock Company is constructing one with a draft of 31 feet. There are, however, a considerable number of new motor vessels which draw slightly less than 27 feet.

Evidence obtained from shipbuilding companies shows that the prevailing draft of the new steam-driven vessels built for operating on regular schedule is now definitely more than 27 feet. We present herewith some typical statements from shipbuilding corporations bearing on the draft of both steam and motor-driven vessels of the newer type:

(1) "*Large combination passenger and cargo* vessels typically have a draft of about 30 feet. Present sizes of steam-driven *cargo* vessels run from 28 to 30 feet in draft."

(2) "*Combination passenger and cargo vessels*, trans-oceanic, average up toward 32 feet draft. Steam and motor *cargo* ships are running well up to 30 feet draft, trans-oceanic, and there are several under our flag which can load to about 32 feet. 27 feet leaves nothing to be desired for *tramp* cargo boats, but will not meet *cargo liner* or *passenger and cargo* liner needs as now set."

(3) "Drafts of over 30 feet may be expected for *passenger cargo* vessels; drafts of over 27 feet for steam *cargo* liners; and a draft of over 27 feet for motor-driven cargo liners."

The primary factors leading to the increase in draft of trans-oceanic vessels are the economies in operation that the larger vessels afford and the increasing demands of shippers for speed in the delivery of goods. Although there appears to be some question as to the maximum size of vessel that is economically feasible, there seems to be no doubt that vessels from 3,000 to 5,000 tons gross are less efficient than those of substantially larger size. Studies by the Emergency Fleet Corporation indicate that nearly every item of operating costs is greater in the smaller than in the larger vessels.[22]

The speed factor is of even greater importance. For most trans-oceanic shipments nowadays, the requirement is for relatively fast vessels. While small boats

[22] The explanation of the continued use of many relatively small vessels in the trans-oceanic trade is that with certain kinds of traffic speed is comparatively unimportant; that there are still many ports which cannot accommodate vessels of from 5,500 to 8,000 gross tons and hence must be content with smaller and slower moving boats; that the hinterland of numerous ports does not furnish a sufficient volume of traffic to warrant the use of the larger vessels; and, finally, that many of the older and smaller ships are not yet ready for the scrap heap.

can be operated at a fairly high rate of speed, cost rises rapidly as the speed is increased. Hence they are profitable only where the time of delivery is relatively unimportant. Fast vessels necessitate a deeper draft than these small ones, owing to the fact that they must be constructed along "finer lines" than the slower boats. That is to say, greater speed requires increased length in proportion to width, this in turn necessitating a greater depth in order to maintain balanced proportions. The newer steam cargo vessels in trans-oceanic trade are nowadays built for a speed of from 12 to 15 knots an hour, and the size of such vessels ranges from 5,500 to 8,000 gross tons.

It is largely because of this emphasis upon speed that the motor-driven vessel is becoming so important. The following statement of Sir Frederick Lewis, Chairman of the Board of the Prince Line, Ltd., indicates the importance which is now being attached to the factor of speed:[23]

> . . . . We have, as you know, already entirely substituted motorships for steamships in one of our long-distance trades, and during the past 12 months we have given a great deal of anxious thought to what is practically the same problem in another of our trades. It is increasingly apparent to your directors that in the principal trade routes, where commodities of high value are carried, speed is a most important factor.
>
> In the particular trade to which I refer foreign competitors are introducing motor-vessels of a speed which will shorten the voyage by several days, and, after full consideration, we decided to replace our existing vessels with fast and up-to-date motor-ships. We have designed the vessels for 16 knots service

[23] From *The Times,* London, Oct. 5, 1927, p. 19.

speed and to be equipped in every way for the requirements of the trade. . . . .

It must be concluded that a channel depth of 30 feet would not be adequate for the most efficient type of ocean cargo and passenger-cargo vessels. While at the present time it would permit the passage of over 80 per cent of the cargo vessels, it would exclude the more efficient types of both steam- and motor-driven freighters and nearly all of the combination passenger-cargo vessels. In view of the trend toward greater speed and accompanying deep drafts, it is clear that by 1940 a limiting depth of 30 feet would be a handicap of major proportions.

A channel depth of 33 feet is a minimum requirement if the St. Lawrence waterway is to serve the purposes for which it is advocated. Such a depth would permit the passage of loaded vessels with salt water drafts of approximately 29 feet, 9 inches. It would thus accommodate nearly all of the steam and motor-driven cargo ships now in existence. It would also accommodate the large grain boats engaged in the Montreal European trade.

It should be observed, however, that even with a depth of 33 feet, the St. Lawrence waterway would not be what might be called a genuinely first-class shipping route. The data submitted above indicate that some cargo tonnage and a large percentage of the passenger-cargo tonnage has a loaded draft in excess of 29 feet, 9 inches. And, as we have seen, the tendency is steadily toward the construction of vessels of deeper drafts.

It will be of interest to present, for purposes of comparison, the data with reference to the depth of other important existing canals and of the leading ocean harbors. The Panama Canal has a depth of 40 feet, permitting the passage of vessels drawing around 36 feet. The Suez Canal, originally constructed to a depth of 26 feet, has been subsequently deepened to 35 feet, and plans are now under way for increasing its depth to 42 feet, 8 inches.[24] The Manchester Ship Canal, completed as long ago as 1894, has a depth of 28 feet. The Kiel Canal, when opened in 1895, had a depth of 29 feet, but the grounding of commercial vessels on several occasions which tied up the traffic of the entire route has led to its subsequent enlargement to 36 feet.[25]

While military considerations have played a part in the determination of the depths of some of these canals, the existing depths are also required for first class commercial purposes. For example, in the season of 1926 there were 49 vessels using the Panama Canal which required a depth of channel of more than 33 feet, 11 of these requiring a depth of more than 36 feet. Similarly, many vessels using the Suez Canal draw well beyond 30 feet; for example, the ships of the Alfred Holt Line, employed in the trade between Great Britain and the Far East, have a loaded draft of 33 feet.

The depths of important ocean harbors afford further evidence of the requirements of modern shipping.

[24] This depth would permit the passage of vessels drawing approximately 36 feet. The Suez Canal requires a larger margin of safety, owing to the accumulation of silt between dredgings.

[25] On account of heavy silting at the west entrance, it cannot safely accommodate vessels drawing more than 30 feet.

The facts as to some of the more important harbors and channel entrances are here summarized. For American harbors the depth given is for mean low water; for foreign harbors it varies, as indicated in each case:

Boston: 35 feet in entrance channel and in main ship channel
New York: 41 feet in Ambrose channel
Philadelphia: Prevailing depth in main ship channel, 34 feet; limiting depth, 31.2 feet
Baltimore: main entrance channel, approximately 35 feet
New Orleans: limiting depth of Southwest Pass, 35 feet; river to New Orleans, 36 feet
San Francisco: entrance channel, 40 feet
Havana: entrance channel, 39 feet; western portion of harbor, 36 feet
Liverpool: depth varies from 37 feet at the lowest to 54 feet at the highest tide
Hamburg: depth of channel in River Elbe varies from 35 feet at the lowest to 38 feet at the highest tide
Rotterdam: depth of channel, 32 feet at high tide (variation in high tides insignificant)
Havre: depth of channel, 40 to 45 feet at varying heights of high tides
Marseilles: entrance channel, 55 feet; limiting depth of deepest basin 33 feet
Genoa: harbor depths, from 30 to 42 feet, mean low water
Calcutta: depths, 26 to 30 feet, at varying heights of high tides
Shanghai: entrance channel, 31 to 33 feet at varying heights of high tides
Yokohama: entrance channel, 35 to 38 feet at varying heights of high tides
Melbourne: entrance channel, 34 feet at mean low water
Sydney: entrance channel, 44 feet at mean low water

The depth in some of these harbors is due wholly to natural causes; but in others it is the result of human improvement. While the deepening of harbors, as in the case of the inter-oceanic canals, has to some extent

been influenced by naval considerations, it remains a fact that commercial shipping has required and has been steadily accommodating itself to an ever increasing depth of harbors.

Summarizing now this discussion of the depth of channel required for opening the Lakes to ocean shipping generally, we have found:

A 25-foot channel would accommodate a negligible percentage of vessels engaged in overseas trade.

A 27-foot channel would limit navigation to local coastwise vessels and the smaller and relatively inefficient ocean freighters.

A channel depth of even 30 feet would not be adequate for the most efficient type of ocean cargo and passenger-cargo vessels now in existence; and the trend is steadily toward deeper drafts.

A channel depth of 33 feet is a minimum requirement if the route is to accommodate the modern type of steam and motor-driven cargo vessels. Even a 33-foot channel would not permit the better class of ocean passenger-cargo liners to enter the Lakes.

CHAPTER IV

THE SHIP OWNER'S PROBLEM

The analysis thus far has proceeded on the assumption that the St. Lawrence waterway is intended to open the Great Lakes to ocean shipping generally. In the light of this assumption we have found that a minimum depth of 33 feet would be required for the needs of future shipping. In this chapter we must shift our discussion from the depth of channel that is required for the needs of first class ocean shipping to an analysis of the feasibility of shipping over the St. Lawrence route from the point of view of the steamship companies. Unless there is reasonable assurance that shipping companies would find it profitable to establish regular first class shipping services into the Great Lakes, it is obviously unwise to recommend the construction of a first class route.

Before attempting to answer the question whether a St. Lawrence route of adequate depth would be used by first class ships, it is necessary: first, to consider the physical conditions of the Great Lakes and the St. Lawrence River and the extent to which they would limit or impede navigation; and, second, to discuss the character of modern shipping service.

I. THE PHYSICAL CHARACTER OF THE ROUTE

In Chapter II the discussion of the waterway was limited to a description of the project under considera-

tion. We now present an analysis of the route from the navigation point of view. For how many months during each year would the route be open to navigation, and to what extent would speed be retarded by restricted channels?

The practical season of navigation for ocean vessels would be limited to about six and one-half months. The season of navigation at Montreal is usually put at about seven and one-half months, by virtue of the fact that over a period of years the *average* number of days that navigation is open is about 227, from April 26 to December 9. A brief analysis will indicate, however, that the *average* duration of the open season is not the practicable shipping season.

The actual dates of opening and closing vary widely in different years. During the last 28 years the date of arrival of the first ocean vessel at Montreal has, in fact, varied from April 7 to May 7, and the date of departure of the last ocean vessel from Montreal has varied from November 25 to December 18. The navigation season at the Soo canals and the Straits of Mackinac show similar variations. In any given autumn, therefore, boats leaving Montreal for Duluth or Chicago with the expectation of getting back to Montreal before the close of navigation would have to reckon on the *earliest probable* closing date at Montreal, as well as at Mackinac or the Soo, rather than on the *average* closing date. It would require from 18 to 20 days for a boat to make the trip from Montreal to Duluth or

Chicago, load, and return to Montreal.[1] This figure allows 13 days for the trip and about a week for the turn-around.[2] Thus, with the date of closing navigation at Montreal coming sometimes as early as November 25, the last departure from Montreal for the Lakes could be made not later than November 5 or 6. While Duluth, Fort William, and the Soo canals are kept open with the aid of ice breakers, sometimes to as late as the middle of December, ice conditions commonly begin to interfere with navigation as early as November 20-25. Accordingly, boats leaving Montreal as late as November 6 would be working on the narrowest of margins, and insurance rates would naturally be increased.

The uncertainty about the actual date of opening in the spring is not of such great importance since boats would not be leaving Montreal for the Lakes until after the route is actually open. The most common date of the opening of navigation at Montreal is around the 26th of April, and it is rarely that opening is delayed until after the 1st of May. Shipping plans could, therefore, safely be made for a May 1st opening of the St. Lawrence route. Thus the actual season of navigation would extend from about May 1st until about the middle of November, or six months and a half.

To afford the reader a graphic picture of the shipping hazards which exist on the Lakes in the spring and

[1] For boats going only as far as Detroit the time would be reduced by about a week and the season correspondingly lengthened.

[2] With grain boats the turn-around would be much shorter.

autumn seasons, we quote below from the *Annual Report* of the Lake Carriers Association, on the opening and closing of navigation for the year 1926. The conditions in this year were exceptional in that the opening of navigation was greatly delayed.

Opening of Navigation, 1926.

On May 6, navigation on Lake Erie as far as Conneaut was on summer schedule. But not so at the lower end of the lake. The immense fields of heavy ice which had been blown down the lake were solid off Westfield to Buffalo and as the wind continued in the same direction for days and days the ice packed in above Buffalo until for miles it was jammed to lake bottom. The ports of Buffalo and Port Colborne for which large amounts of grain had been consigned were isolated from navigation.

The clearing from Buffalo on April 30 of the steamer *Saucon* marked the beginning of the worst and most prolonged blockade Lake Erie has known for 50 years. From May 1 on more and more steamers daily attempted to get out of both Buffalo and Port Colborne intent upon fulfilling opening trip charters, or to enter the coal and ore trades. But each and all joined the tightly wedged *Saucon*. And to this ever growing fleet there were added the grain laden vessels down-bound. On May 8 there were 38 upbound and 25 down-bound vessels and perhaps 15 Canadian steamers fast in the ice 14 miles above Buffalo and abreast of Port Abino. Eighteen more steamers cleared from Buffalo on May 9 hoping that by reaching the others a combined attack might open a channel but they were unsuccessful. On this day, however, 13 of the down-bound fleet laboriously worked their way through the softening ice into Buffalo Harbor and thus opened the port to the grain trade. On May 10 a few of the steamers in the westbound fleet got out of the windrows but there were still 50 vessels that had not made much headway. By May 12 vessels were working in and out of Buffalo but with difficulty. And when unfavorable winds blew, the ice fields closed in and the blockade was renewed . . . . May 26 was characterized by the absence of a

vessel in the ice, this for the first time since the *Saucon* departed from the harbor entrance on April 30. However, on this late day there was no open water visible from the port of Buffalo.

Closing of Navigation, 1926.

Winter and a heavy gale came out of the northwest suddenly and destructively on November 18 and from that day on to the close of navigation the upper lakes, particularly Lake Superior, were swept by a succession of storms and subjected to the lowest temperatures known in years for that season. During the night of November 26 thermometers at Duluth and Sault Ste. Marie dropped to 2 below zero and to 12 below at Fort William and Port Arthur. A gale had been blowing for two days and when the boats came out of shelter four inches of ice had formed in St. Marys River, from Pipe Island to the Dike. The assistance of tugs was required to release some that became stuck in the ice but toward evening all boats in the river were moving. The next day, however, the tugs *Illinois* and *L. C. Sabin* encountered great difficulty in getting 16 steamers up the lower river. Thirty hours' time was lost in the run from Detour to the locks.

On December 1 the river ice became thicker and the two tugs, now aided by the *Alabama* and *Iowa,* were a help to eleven upbound vessels but there were eight steamers stuck at Rock Cut in the West Neebish Channel and the temperature was due to go below zero again. In the meantime, it may be added, there had been a delay in Canadian grain loading on November 30 because of heavy snowfall, the Board of Grain Commissioners having issued an order prohibiting the loading of grain during heavy rain or snow. In consequence it was four o'clock in the afternoon before the resumption of loading was permitted, leaving a space of only eight hours to get a large fleet out before the expiration of insurance. So there began operations that resulted in all former grain loading records going by the board.

The car ferry *Sainte Marie* was secured and sailing from the Straits of Mackinac she started on December 4 to break the blockade. By this time more than 60 downbound and 25 up-

bound steamers were ice bound in St. Marys River with the thermometer at 12 below zero and the number constantly augmented by later arrivals. The steamer *Coulee*, which had locked down in the afternoon of November 30, was tightly caught in the ice at Rock Cut and was partially swung across the channel. She was the key boat to the blockade and next to her was the *General Garretson*. Captain F. A. Bailey took sole charge of the ice breaking operations and at 11:30 a. m. on December 7, the *Coulee* was released. The *General Garretson* then became fast in the spot where the *Coulee* had stuck and was not released until the next day. The operations then turned to the big steamer *William G. Mather* which was behind the *Garretson*. Little time was lost in getting her moving and with her 62-foot breadth of beam she made a channel for the vessels following her. On the morning of December 9 as the 100 or more downbound vessels slowly moved toward Lake Huron the blockade in the West Neebish Channel was pronounced broken, although it had been necessary several times to concentrate efforts on vessels stuck in the Rock Cut. To alleviate fuel shortage the Association ordered the *J. J. Turner* to discharge part of her coal cargo at Kemp's dock. On the morning of December 10 a temporary check ensued when the *Bricoldoc* became caught in the West Neebish Cut and held up 80 vessels behind her, but she was out of it by noon. By December 11 all the upbound fleet had reached the Sault and the downbound boats were thus enabled to use the upbound channel.

In the light of these conditions, it is apparent that ocean vessels leaving Montreal for the upper lakes after the middle of November would run the risk of being tied up in the Lakes for the entire winter. It is also clear why insurance rates have to be advanced sharply at this season of the year. The lake boats can afford to continue operations somewhat longer than would be feasible for ocean vessels by virtue of the fact that it

does not matter much whether they winter in the upper or in the lower lakes.

Ships would have to operate between Montreal and lake cities at about three-quarters their normal rate of movement. The St. Lawrence route comprises, in addition to the unrestricted stretches of open water, both canals and restricted channels. There would be 25 miles of canal in the St. Lawrence River, with eight or nine locks; 26.75 miles of canal with seven locks, through the Welland; and 1.9 miles of canal, and one lock, through the St. Marys Fall Canal at the Soo—a total of 53.6 miles of canal. In addition, the St. Lawrence has 67 miles of restricted channel—the least width through the Thousand Island section from Lake Ontario to Chimney Point being 500 feet.[3]

From the head of navigation in Lake Superior to the head of the St. Lawrence River, via the shortest navigable route, there are in all approximately 150 miles of channel navigation. This is made up of the following stretches: The St. Marys River (exclusive of the Sault Ste. Marie canal) connecting Lake Superior with Lake Huron, 61 miles; the channel through the shallow water in the lower end of Lake Huron, 2.1 miles; the St. Clair River connecting Lake Huron and Lake St. Clair, 40 miles; Lake St. Clair, 13.7 miles; and the Detroit River connecting Lake St. Clair with deep water in Lake Erie, 32.3 miles.

[3] From Montreal to Quebec the channel is also restricted, being 450 feet in the straight portions and from 600 to 900 feet in the bends.

Delayed movement is involved both in the passage of the locks and in navigating the canalized river and the restricted connecting channels. Roughly an hour must be allowed for the passage of each lock. While an actual transit may be made in a shorter time, allowance must be made for accidents and delays in entering a lock.[4] Passage of the locks would thus involve a total delay of about 17 hours each way. In the canalized section of the river speed would be reduced from, say, twelve miles an hour to about four miles an hour, and in the improved connecting channels to about eight miles an hour. The delay incurred because of this reduction of speed in canals and channels works out at about 20 hours each way. In all, then, retardation of sailing time would amount to approximately 37 hours each way, or 74 hours for the round trip. Stated another way, it would take a ship over 12 days to make the round trip from Montreal to Duluth, whereas under conditions of unrestricted navigation the same boat would make the distance in about nine days.

II. THE CHARACTER OF MODERN OCEAN SHIPPING SERVICE

As a second step in our analysis, preliminary to considering the St. Lawrence from the ship owner's point of view, it is desirable to describe briefly the general character of ocean shipping service today and the changes that have been occurring in recent years.

[4] In the Panama Canal the time has been reduced to approximately one-half hour. At the Soo the average time, for the season of 1926, was one hour and eleven minutes.

The world's transoceanic trade has until fairly recent times been carried chiefly by two classes of ships—the general trader (tramp) and the liner. The distinction between the tramp steamer and the liner may be stated as follows: the tramp keeps no regular schedule and is willing to pick up miscellaneous and varied cargo, wherever it may be found. The liner, on the other hand, proceeds on a regular schedule between definite termini. The liner handles sometimes only freight and sometimes both cargo and passengers.

During recent decades, however, the character of the "general trader" has been changing. With the increasing emphasis on regular schedules in business activity, the irregular service afforded by the old tramper is placed at a disadvantage. Accordingly, the so-called tramp vessel is nowadays commonly chartered either for a trip between designated points or for a definite period of time. It is employed chiefly for the transport of full cargoes of bulk commodities. The practice of "going anywhere" with a view to picking up part cargoes of miscellaneous traffic is steadily declining.

A new class of ocean carrier has also attained some importance in recent times. A number of large industrial corporations now own and operate their own vessels. In some cases the corporation operates a regular liner service, adjusting schedules to its own needs, but selling such space as may be available to the general public. In other cases, particularly with bulk commodities, the company carries only its own tonnage. These boats are competitors of both the liner and the chartered

vessel. Among the private industrial corporations which own and operate vessels of their own may be mentioned the following: The United Fruit Company, The Atlantic Fruit and Sugar Company, The United States Steel Corporation, The Bethlehem Steel Company, The W. R. Grace Company, and Sota and Aznar (Spanish steel company). Mention may also be made of the large number of tankers owned and operated by petroleum companies.

Liners and industrially owned vessels are steadily gaining at the expense of the tramp. This fact has been generally recognized by the shipping industry and also by students of the shipping problem. In order to indicate the extent to which the tramp is now used in the trade between the United States and Europe, we have compiled a schedule of the vessels chartered for trade between all United States ports north of Hampton Roads and Europe for the six months period April to September, 1928. (See Appendix B, Section IV.) The insignificant rôle now played by the chartered vessel is shown by the fact that there were only forty sailings of vessels of this kind from all of these ports during the six months period—an average of six or seven a month. They handled in the main odds and ends of trade—shipments of scrap iron to Danzig, agricultural machinery to Russian ports, asphalt to Rotterdam, and odd cargoes of such commodities as cotton, sugar, and grain to miscellaneous destinations.

For purposes of comparison with these tramp sailings, it may be noted that the number of sailings of

passenger-cargo vessels from North Atlantic to North European ports is more than 80 per month, and that the number of sailings of cargo vessels is also in excess of 80 per month. (See Appendix B, Sections I, II, and III.)

The reasons for the decline of the tramp may be briefly indicated. The increasing emphasis upon regular scheduling in business activity; the increase in wealth which gives rise to a greatly expanded volume of international commerce; the growth and spread to all continents of rapid means of communication; the increasing interdependence of the various trade regions of the world upon one another; and the advantages of large scale shipping organizations [5] have combined to narrow the field for the tramp vessel.

Both passenger-cargo and cargo liners are to an increasing extent taking even the bulky commodities away from the tramps. High grade traffic constitutes the basis for a successful liner service. But such ships are also in the market for at least enough low grade bulky freight to make up their deadweight cargo. Since such traffic is necessary as ballast for the vessel, the operator of the liner can afford to offer very attractive rates to

[5] Large scale business enterprise has invaded the field of ocean transportation as it has the field of industry and commerce generally. The great liner companies maintain a world-wide network of regular services. They control their own port facilities and frequently operate coastwise feeder services in conjunction with their overseas trade. Through conferences and informal agreements groups of companies coöperate in the making of rate schedules and in the allocation of trade regions served. The advantages which the large steamship companies and combinations possess over the small independent operator are analogous to those possessed by the large industrial enterprise.

the shipper. The combination of regular service, speed, and low rates renders both the passenger-cargo and the cargo liner very effective competitors of the tramp, not only for general cargo traffic but also for lower grade bulky commodities. This close competition of course gives the shipper the benefit of lower rates than might otherwise prevail.

The companies which have established liner services to handle their special products have also limited the opportunity of the tramp. These vessels are, in the main, used for the carrying of commodities of a type to which the chartered vessel is moderately well adapted. These specially constructed vessels, therefore, have marked advantages over the tramp in that their equipment and facilities are especially designed for the particular type of traffic with which the company is concerned, and in that ownership of the vessels gives the company control of its transportation requirements.

Thus the tramp steamer which has occupied so important and so romantic a place in ocean commerce finds its field of opportunity increasingly restricted.

III. WOULD FIRST CLASS CARGO LINERS ENTER THE LAKES IF A 33-FOOT ROUTE WERE PROVIDED?

We we may now turn to an analysis of the commercial feasibility of the St. Lawrence route from the point of view of the ship owner. The seasonal character of the waterway and the obstructions to navigation, to which reference has been made in the first section of this chapter, clearly indicate that the route has shortcomings

from the ship operator's point of view. How serious these handicaps to shipping are, however, is a question which cannot be answered by reference to any existing statistical data. It involves a question of judgment; and the only judgment that is valuable is that which experienced shipping men can give. Accordingly, we submitted to the leading shipping companies of the world a statement showing the physical limitations of the route, substantially as outlined above, and asked for the benefit of their judgment "as to the practicability of operating first class cargo liners over the St. Lawrence route"—assuming that a depth of 33 feet[6] were provided and that potential traffic were available. In order to raise squarely certain problems which had occurred to us, we asked that replies be given to the following specific questions:

First, assuming that adequate channels were constructed and that harbor facilities comparable to those available at the better seaports were provided, would it be practical to operate regular liners out of the Great Lakes during the summer months and shift the vessels so employed to regular services on other trade routes during the winter months?

Second, would it be feasible to operate ships over the St. Lawrence route as regular liners during the summer months and then place them in tramp service during the closed season of the St. Lawrence?

Third, would it be practical to operate vessels over this proposed route during the summer months and lay them up idle during the winter season?

The view is practically unanimous that first-class cargo service would not be established. Replies to our

[6] It will be recalled that such a depth would accommodate cargo ships drawing up to nearly 30 feet, salt water draft.

communication were received from most of the leading shipping companies of the world; and there was a surprising unanimity in the opinions expressed. Before giving typical excerpts from the letters classified with reference to each of the questions asked, four quotations of a general character taken from four different letters will be presented:

(1) Generally speaking, a trade which can be conducted during a portion of the year only would appear to be more suitable for tramp tonnage of a handy size than for regular liners.

(2) Among shipping men here there is no one who imagines that either large passenger liners or large cargo liners would utilize the proposed waterway even if it were built. Some of the cargo liners could, of course, make the trip to the lakes through the deep canals, but we do not see where they could secure general cargoes to warrant the establishment of regular services except at rates which would be prohibitive.

(3) I may say that, if the trip to the head of the lakes and return to Montreal would require as long as 18 days, I do not believe that any ship owner would attempt to put cargo liners in that trade. In 18 days vessels could make a trip to Europe, and it is my impression that the traffic would not be able to pay the higher rate which the vessel would have to charge for making the trip into the lakes.

(4) I do not think that regular lines could be worked up to points so far in the interior of North America and open only during a relatively short period of the year. Regular lines would probably continue to confine themselves to ports on the St. Lawrence to and from where they could combine their cargo business with passenger traffic. It is obvious that passengers would land and embark as near the sea as possible and would not like to be transported by water over the long inland trip.

The replies to the specific questions asked afford additional light as to the reasons why the route is not feasible for first-class cargo vessels.

Question 1

Would it be practical to operate regular liners out of the Great Lakes during the summer months and shift the vessels so employed to *regular* services on other trade routes during the winter months?

Answers

(1) There is no general increase of overseas trade during the winter months which would enable established trade routes to absorb this additional tonnage, and competition is too keen to permit outside tonnage to come in and take the business away from the established lines for part of the year.

(2) To operate successfully a regular service the trade should be maintained by vessels especially adapted for it, and with as much regularity as possible. It would, therefore, be difficult to operate regular liners out of the Great Lakes during the summer months and shift these vessels to other regular trades during the winter months.

(3) Liners built for this special trade cannot possibly be employed in other regular trade routes during the winter months, because other routes which would require the same quality of steamers generally must be supplied with adequate tonnage throughout the year, and we do not know of one of our own services which would require an extra supply of tonnage during the winter.

(4) It would be quite impracticable to operate regular liners out of the Great Lakes during the summer months, because in these days of intense competition no regular service of such "irregular" nature is likely to meet with the support of the necessary clientele to make the venture a success.

Only three or four of the replies received conceded that it might be possible to shift cargo liners engaged in the St. Lawrence trade to other regular routes during the winter months. Two of these were, however, convinced that in any event cargo liners would not come into the Lakes.

Question 2

Would it be feasible to operate ships over the St. Lawrence route as regular liners during the summer months, and then place them in *tramp* service during the closed season of the St. Lawrence?

Answers

(1) The suggested alternative of placing in tramp trade during the closed season of the St. Lawrence vessels employed as regular liners during the summer months appears more feasible than the above; but as the question involved here calls for the construction and use of a large and fast type of cargo liner on the St. Lawrence route, I doubt very much whether a vessel of this type could be operated profitably on the open charter market. Moreover, the range of employment for these vessels, while engaged as tramps, would be strictly limited owing to the fact that they would be required to re-enter their regular service at specified dates.

(2) Vessels employed as regular liners on the Lakes would have difficulty in dovetailing tramp schedules during the winter season with their schedules for the Great Lakes service during the summer season.

(3) It depends upon the kind of ships employed on a regular St. Lawrence route during the summer months, whether same can be profitably employed as tramp tonnage during the off season.

(4) Expensive cargo liners that have a speed of 13 knots or more, and adapted to specific trade requirements, could not, with profit, engage in what would have to be at best a miscellaneous tramp service in the winter season.

Question 3

Would it be practical to operate vessels over this proposed route during the summer months and *lay them up* during the winter season?

Without exception, operators were of the opinion that no boat could engage in the Great Lakes during the summer season and obtain sufficient revenue to lay up during the winter season. To be successful, it would have to be able to engage in winter service elsewhere, either on regular service or in the capacity of a chartered vessel.

In the light of the replies received from the shipping companies, it is clear that first class cargo liners would not operate over the St. Lawrence route even if a channel depth of 33 feet were provided and potential traffic were available. It is possible that the strong adverse opinion rendered by the shipping companies which replied to our inquiry represents a mistaken judgment, but inasmuch as these men speak from long practical experience with shipping problems we must accept their judgment in the absence of any conflicting evidence or testimony. We are therefore forced to the conclusion that the character of shipping services over the St. Lawrence route could, under no circumstances, be made to compare favorably with those established at the leading North Atlantic ports.

IV. WOULD ANY OCEAN CARRIERS ENTER THE LAKES?

The preceding section has given a conclusive answer only to the question whether first class cargo liners

would enter the Lakes if an adequate channel depth was provided. We must now inquire whether the considerations which rule out the navigation of a 33-foot channel by the large cargo liners would operate to prevent the utilization of, say, a 27-foot channel by smaller vessels. It may be recalled that a channel depth of 27 feet would permit the passage of a considerable number of second class cargo liners and tramp vessels—to be specific, 40 per cent of the net tonnage of grain tramps loading at Montreal and 38 per cent of the cargo tonnage engaged in the overseas trade of the United States.[7] There are four types of ships to be considered, namely, (1) second-class cargo liners; (2) tramp vessels chartered for full cargoes of bulky commodities; (3) tramp vessels entering the Lakes as "general traders" to pick up miscellaneous cargo; and (4) industrially owned and operated vessels.

The answers received from the shipping companies about the feasibility of first-class liner service on the St. Lawrence did not specifically consider whether the case would be any different with smaller liners. Many of the letters clearly indicated that no liner service of any kind would be established; but a few of them, on the other hand, implied that it would be *particularly* difficult for the large and costly cargo liners to find remunerative employment in the winter season.

It is doubtful whether any regular liner service would be established. It is difficult to see wherein the handicaps to the smaller cargo liner would on the whole be less

[7] See Chapter III, pp. 43, 47.

than those to the larger liners. The retardation of speed between Montreal and lake cities would matter somewhat less to the smaller than to the larger vessels; but, on the other hand, between Montreal and foreign ports the smaller vessel would be at a distinct competitive disadvantage for most traffic. Moreover, as we have seen, except for the subsidized Shipping Board boats, the smaller cargo liners have already largely disappeared from the North Atlantic trade, with the tendency steadily toward larger and faster boats.[8] And it is only in the North Atlantic trade, it may be recalled, that the St. Lawrence waterway possesses a distance advantage as compared with alternative rail and water routes to overseas markets.[9]

An important handicap to the establishment of a second-class cargo liner service is the fact that the slow service involved would make it impossible to compete for the remunerative mail, express, and parcel post traffic, for high value merchandise, and for the refrigerator trade in meats, vegetables, and fruits.

Nor is there much reason for believing that the smaller cargo vessel could be more advantageously shifted than the larger cargo liners to other regular trades in the winter season. In the North Atlantic trades, the volume of shipping is somewhat smaller in the winter than in the summer months; and the letters received from the shipping companies did not indicate that there were any regular trade routes which were in

[8] See particularly, pp. 53-57.
[9] See pp. 29-34.

need of additional tonnage during the season of closed navigation on the St. Lawrence.

It would appear at first thought that the small liner might have a somewhat better opportunity than would the large one to engage in the tramp trade during the closed season. The declining importance of tramp trade in general, however, indicates an extremely restricted opportunity for cargo liners built for the St. Lawrence trade to find remunerative employment in the winter season. The letters indicated difficulties in dovetailing regular schedules on the Great Lakes in a summer season which must begin and end at specified dates with tramp service during the closed season. They also call attention to the fact that cargo liners constructed for the lake trade might have to be adapted to specific trade requirements which would militate against their adaptation to miscellaneous tramp service in the winter season. In view of all of these considerations, it appears very doubtful whether second-class liners would be operated on regular schedule between lake cities and foreign markets. In any event it is clear that liner service could be profitably conducted only between lake cities and Europe, for our traffic analyses indicate that it is in this trade alone that there is a sufficient balance of outbound and inbound traffic to warrant the establishment of a regular service.

Chartered vessels would find a very restricted opportunity. The letters which we wrote did not specifically inquire whether the St. Lawrence route might prove attractive to the so-called tramp vessels operating on a

charter basis. A number of the answers implied that the route would be adapted to tramp service; but two of them expressed doubt as to the feasibility of the route even for the chartered vessel. We quote below from these two answers, as follows:

(1) I can speak from personal experience, as we have had tramp vessels bound by contract to several summer seasons of St. Lawrence trade, and have found it difficult to get freights for the winter months to give even a most modest remuneration.

(2) I do not think the Great Lakes trade would prove profitable to tramp tonnage. A tramp vessel in order to earn money must keep in position to take advantage of the *best* charters available. If she contracts to go from Montreal to the head of the Lakes for grain, involving a trip of 18 days, she runs the risk of losing a more valuable charter which she might obtain if not tied up for a long inland trip. And, I would make a second point, namely, that a small boat of this size could not carry grain from the head of the Lakes to Liverpool at a rate comparing favorably with that which shippers can obtain via the Great Lakes bulk freighters to Montreal and large ten to twelve thousand ton cargo liners out of Montreal. She would be less efficient than your Great Lakes bulk freighter for the lake part of the voyage, and less efficient than the first class cargo liner for the trans-Atlantic run, Montreal to Liverpool or the Continent.

The nub of the problem with reference to the chartered ocean vessel is indicated in the second quotation above. Whether tramp steamers would be chartered for the movement of full cargoes out of the Lakes will depend primarily upon the competitive conditions which they will face on the Lakes. The only important export lake traffic adapted to the chartered vessel is grain. In the analysis of the grain traffic problem, in Chapter

VIII, the conclusion is reached that even if a deep waterway were available it would be utilized in the movement of this traffic by ocean vessels only for a period of about six weeks during the autumn peak season. Our traffic analyses indicate the probability of some inbound traffic adapted to chartered vessels.

The St. Lawrence route is somewhat better adapted to the general trader interested in miscellaneous cargo. The general trader would not be subjected to as severe competition in the Lakes as would vessels chartered for the grain trade; and it is not impossible that they could command rates between lake cities and certain foreign markets low enough to compete with combination rail-and-water carriers and yet high enough to yield a return to the ship owner. Even these "general traders," however, cannot escape the problem of finding remunerative employment during the season when the St. Lawrence route would be closed. It is necessary to assume that at the date that the deep waterway would be opened for navigation there will be a sufficient number of tramp vessels serving as "general traders" to carry all of such traffic as is available. The St. Lawrence route, through the diversion of traffic from the railways, would create additional boat traffic for the summer season; but it would create no additional winter business. Consequently, the margin of profit in the summer season would have to be somewhat above the normal in order to compensate for possible smaller earnings in the winter. While the case is not altogether clear, it is not impossible that "general traders" might

put into the Lakes in the summer season to pick up miscellaneous cargo. It must be recalled, however, that the "general trader" type of shipping service is of steadily declining importance.

The route has, perhaps, even more possibilities for the industrially owned cargo freighters. Large industrial organizations, such as those engaged in the iron and steel and motor industries, might construct, or acquire, vessels which would utilize this route in the transportation of their own raw materials and finished products. The extent of such traffic possibilities is considered in connection with our traffic analyses in Appendixes D to J.

It remains to say a word about the possible utilization of the St. Lawrence route by vessels engaged in the coastwise trade. Such boats are typically of a draft which could navigate a 27-foot channel. Whether they would establish either regular or intermittent service between Atlantic ports and Great Lakes cities will depend upon the types of traffic available and the costs of moving it by water as compared with much shorter rail routes. Our traffic analyses show that there is at least a minimum of tonnage that might be moved between the Lakes and the Atlantic seaport in coastwise trading vessels.

In the preceding chapters it was shown that if the St. Lawrence waterway were to accommodate the classes of shipping services which it had been assumed would be developed, a channel depth of 33 feet would be re-

quired. The conclusion of the present chapter is that such a depth of channel is not required for the only type of shipping service that might, under any circumstances, be expected to develop from Lakes to tidewater. The typical "general trader," as also the run of vessels engaged in the coastwise trade, could enter the Lakes over a channel 27 feet in depth. If, therefore, the St. Lawrence waterway is to be constructed it does not need to be of a greater depth than present plans call for. Such a route would not, however, make the St. Lawrence a great thoroughfare for ocean commerce and it would not make Cleveland, Detroit, and Chicago maritime rivals of the great Atlantic ports. Whether such a project is economically to be justified depends upon its cost in relation to the transportation saving which it might effect.

CHAPTER V

THE COST OF A 27-FOOT WATERWAY

This chapter deals with the cost of a 27-foot Great Lakes-St. Lawrence *navigation* system. The cost of the *power* development is considered in Chapter X. The analysis is presented in two sections. Estimates of the capital investment required to make the route practicable for deep draft vessels are given in Section I. The amount of the annual overhead and maintenance charges is considered in Section II.

I. CAPITAL INVESTMENT

Improvements required to make the Great Lakes-St. Lawrence a practicable navigation route with a minimum depth of 27 feet, may be classified under three heads: (1) Improvements needed in the St. Lawrence River; (2) improvements needed in the restricted channels between and in the Great Lakes; and (3) improvements needed in Great Lakes harbors. As a basis for computing the inclusive capital outlays for the completed waterway an estimate of the cost of each class of improvement is set down. The figures for the cost of improvements required in the St. Lawrence and in the Great Lakes channels are derived from the *Report* of the Joint Board of Engineers,[1] with certain estimated

[1] See *Report* of Joint Board of Engineers on St. Lawrence way and Appendices B and C to that report.

additions, as indicated. The cost of improving Great Lakes harbors we have estimated.

1. *Cost of improvements in the river.* For convenience of reference, the Joint Board of Engineers has divided the St. Lawrence between the lower end of Lake Ontario and Montreal into five sections. (See inset map, page 26.) For each section it has recommended a program of improvements which in its judgment will best serve the purposes of both power and navigation.[2] Works required for each section together with the estimated costs thereof are classified under three heads: works solely for navigation, works primarily for power, and works jointly for power and navigation. The last item includes such works as main channel excavations and enlargements, dykes, drainage, property damage, relocation of highways and railroads. To arrive at a capital cost for navigation works alone, therefore, it is necessary to make some assumptions with reference to the items of joint cost. For the present we are arbitrarily dividing joint costs between power and navigation on an equal basis.[3] The official estimate for improving the St. Lawrence, with such an allocation, is shown in the table on page 87.

The estimates of the Joint Board of Engineers do not include interest during the period of construction. This

[2] For the International Rapids section alternative plans are recommended by the United States and by the Canadian engineers. See table, page 87.

[3] For a discussion of the capital cost of power and of navigation works with the allocation of joint costs made on a different basis, see page 217.

COST OF A 27-FOOT CHANNEL IN THE ST. LAWRENCE [a]

(Project recommended by United States Engineers)

Section	Cost of Works Jointly for Navigation and Power	50 Per Cent of Joint Costs	Cost of Works Solely for Navigation	Total Navigation Costs
Thousand Islands........	....	....	$ 1,532,000	$ 1,532,000
International Rapids	$106,500,000	$53,250,000	22,506,000	75,756,000
Lake St. Francis.........	....	....	1,330,000	1,330,000
Soulanges................	34,686,000	17,343,000	32,859,000	50,202,000
Lachine..................	....	....	55,839,000	55,839,000
Total	$141,186,000	$70,593,000	$114,066,000	$184,659,000

[a] Compiled from *Report* of Joint Board of Engineers on St Lawrence and Appendix C to this report. This table is based on a single-stage improvement for the International Rapids section of the river. A 27-foot project with a two-stage development in the International Rapids section, as recommended by the Canadian engineers, is estimated to cost $188,613,000.

omission is admitted by the Board.[4] Accordingly, it is necessary to add this item of cost to the figures given above if we are to arrive at an estimate of the inclusive capital requirements for the deep waterway. The time required to build the waterway is officially estimated at eight years.[5] The amount of funds required annually would of course vary somewhat from year to year. Very large sums would be required the first year to start construction works, and large amounts would be needed the last year. Assuming, however, that funds are expended at a uniform rate, the average period for the computation of interest on total capital would not differ appreciably from four years.[6] The rate at which money could be borrowed may be conservatively placed at 4 per

[4] *Ibid.*, par. 229.

[5] *Ibid.*, par. 254.

[6] Engineering experience shows this to be a satisfactory method for estimating interest on capital during construction.

cent.[7] We have, then, an addition of 16 per cent on the engineers' estimate for interest. This would increase the cost of the river development by approximately $29,600,000 and bring the total estimate for navigation costs up to $214,259,000.

2. *Cost of improvements in Great Lakes channels.* To make the Great Lakes a coordinate part of a deep waterway system, it is necessary to: complete the Welland Ship Canal; deepen and widen the connecting channels between Lake Erie and Lake Huron; deepen and widen the approach channels to the Sault Ste. Marie canals; construct a new lock on the St. Marys River; and provide compensating works for the control of lake levels. The estimated cost of these improvements, other than expenditures required to complete the Welland, are summarized below:[8]

Channel excavation, Lake Erie to Lake Superior......	$54,900,000
Lock in St. Marys River...........................	6,500,000
Compensating works, Niagara and St. Clair Rivers....	3,700,000
Total	$65,100,000

With these cost estimates, as in the case of those for the River development, no allowance is made for interest during the period of construction. This interest, computed as above, would amount to $10,400,000, which would bring the cost of improvements in the lake channels up to $75,500,000.

[7] Federal Land Bank loans are on a 4 per cent basis; the same applies to the securities of the Port of New York Authority. Also, 4 per cent has been used by Federal authorities in estimates on the Colorado Boulder Dam project.

[8] *Report* of Joint Board of Engineers, par. 105.

Experience shows that great waterway projects have practically never been completed within original estimates of cost. This is no doubt in part attributable to the fear that popular support will be difficult to obtain if the cost figures are of staggering dimensions. There is hence an inevitable tendency in the direction of conservatism in the making of estimates. Despite the fact that estimates for the Manchester Ship Canal were presented "with a fullness of detail seldom equalled," the canal cost more than twice the amount of the original estimate.[9] The actual cost of the Chicago Drainage Canal when completed was $53,000,000, compared with an estimated cost of $16,000,000.[10] The Suez Canal, which it was thought could be built for $30,000,000, cost $80,000,000.[11] At the time of the passage of the bill for the construction of the Panama Canal it was estimated that the cost would be approximately $140,000,000, and that in no case would it exceed $160,000,000. Yet this canal cost $375,000,000, the increase being in part due to a change in plans as the work progressed.

The St. Lawrence, both in its magnitude and its complexity, presents perhaps greater engineering difficulties than any of the above named projects. The control of lake levels and the handling of ice in the St. Lawrence present technical problems of peculiar difficulty. Two illus-

[9] The estimated cost was approximately 8 million pounds. The expenditures on capital account up to December, 1909, were over 16 million pounds. See Moulton, Harold G., *Waterways Versus Railways,* p. 150.

[10] *Ibid.,* p. 361.

[11] *Encyclopedia Americana,* Vol. XV.

trations will show the large element of uncertainty in the engineering phases of the project.

> The ice question in the St. Lawrence is a very grave matter, and the method of its control must be absolutely settled before either public or private capital will be justified in building extensive water power plants on the St. Lawrence. . . . . Existing plants at the St. Lawrence on both sides of the river . . . . prove that the only form of power industry that can subsist on the St. Lawrence River under present ice conditions are industries given over entirely to chemical production, where interruptions to service are relatively unimportant.[12]
>
> The design of regulating works that will satisfactorily meet ice conditions in the Niagara River, and will accommodate the great volume of shipping in the St. Clair River, offers many complications. The designs forming the basis of the estimates of the cost herein presented are intended to afford only a reliable indication of the minimum cost, which might be increased materially by elaborations deemed necessary to meet the unusual requirements.[13]

With reference to the magnitude of the task involved in developing the St. Lawrence for navigation and power purposes, the following statements are illuminating:

> No great dam has hitherto been built anywhere except in locations offering seasons of low flow for the installation of the necessary temporary works. Forty thousand cubic feet of water per second has hitherto been considered an excessive amount of water to handle at the time coffer-dams were being placed. On the St. Lawrence, coffer-dams will have to be placed when four and one-half times as much water is being discharged as has been hitherto successfully controlled.[14]

[12] Hugh L. Cooper Company, *Report* to International Joint Commission on Navigation and Power in the St. Lawrence River, 1920, pp. 23-24.

[13] Appendix B, "Lake Levels and Outflows," *Report* of Joint Engineers on St. Lawrence Waterway Project, p. 57.

[14] Hugh L. Cooper & Company, *Report* on Navigation and Power in the St. Lawrence River, p. 21.

The conditions in general on the river call for power units of larger dimensions than have yet been built, and the Board recognizes the uncertain trend of present practice with regard to draft-tube design.[15]

Taking into account, therefore, the difficult engineering problems involved in the St. Lawrence project and the history of other navigation projects, we have reason to believe that the cost of the completed waterway would far exceed the Engineers' estimate, perhaps by 50 or 100 per cent. In order to be extremely conservative, we are making an allowance of only 20 per cent for overrun.

The inclusive cost of the navigation project, exclusive of harbor development, would be not less than \$347,000,000. Of this amount, approximately \$257,000,000 would be for the development on the river and \$90,000,000 for improvement of the lake channels. The reader should bear in mind that we have omitted from the cost of the river development one-half of the costs in the International Rapids and Soulanges sections on the theory that the cost here should be evenly divided between navigation and power.

3. *The cost of harbor improvement and port development.* If the Great Lakes-St. Lawrence deep waterway is to be of any commercial value, it must be coördinated with efficient lake ports. A waterway without terminal connections and facilities would be like a railroad whose lines reached only to the borders of the great terminal markets. In estimating the cost of a railroad we would

[15] Appendix C, "Detailed Plans and Estimates for the Improvement of the St. Lawrence," *Report* of Joint Engineers on St. Lawrence Waterway Project, p. 4.

never think of omitting the cost of providing both terminal facilities and access to such facilities. But such a practice is habitual in the case of government waterway projects. For example, the $101,000,000 improvement of the Erie Canal, voted in 1904, made no provisions whatever for terminal facilities; and with deep concern it was discovered some years later that the State of New York would have to appropriate another $19,-800,000 for terminal works. Similarly, in the present instance, the official estimates of the cost of opening the Great Lakes to ocean shipping omit the cost both of deepening lake harbors and of developing the necessary port facilities.

In the absence of comprehensive engineering surveys, it is impossible to present any very trustworthy estimates of the cost of the necessary harbor improvements in lake cities. An analysis of the condition of present lake harbors, the character of the improvements required, and the cost of harbor and port developments elsewhere, will, however, give us a fairly accurate idea of the magnitude of the expenditures involved.

It will be useful, first, to contrast the unimproved harbor sites on the Great Lakes with some of the great natural harbor areas along our ocean coasts. The Puget Sound inlet, containing some 2,000 square miles of water surface,[16] is equivalent to one-fourth the area of Lake Ontario. The minimum depth of water in this

[16] Estimate based on the dimensions of the Strait Juan de Fuca, Puget Sound proper, and the other principal sounds and bays as given in the *Annual Report* of the Chief of Engineers, U. S. Army, 1927.

great inlet is over 100 feet. San Francisco Bay is 40 miles long, 3 to 10 miles wide, and has 36 square miles of anchorage space with depths of 40 feet or more.[17] The Lower Bay at New York contains about 36 square miles; the Inner Harbor includes more than 5 square miles of water surface with a depth of 40 feet or more, and the total shore line of the inclusive port district of New York (under the plan of development proposed by the Port of New York Authority) is estimated at about 800 miles.[18]

The locations of lake harbors are the mouths of small streams. The channels of these streams are tortuous and sluggish; they are not only too narrow to permit the construction of piers at right angles to the banks, but they are even too narrow to permit the modern lake freighter or ocean vessel to turn around. Except as improved, they have depths ranging from 2 or 3 up to 16 or 17 feet. The natural bays into which they discharge are open, offering practically no protection to shipping, and are subject to heavy shoaling. Only two or three lake cities have naturally protected areas which could be improved as outer harbors.

The improvements which have heretofore been made in lake harbors in the interest of lake navigation are entirely inadequate for overseas trade. Cleveland has

[17] *Ibid.*

[18] The area of the Lower Bay is estimated on the basis of the United States Engineers' *Report;* the area of the Inner Harbor is taken from the *Harbor Plan of Chicago,* Commercial Club of Chicago, 1927; and the length of shore line is taken from the *Report* with Plan for the Comprehensive Development of the Port of New York, Port of New York Authority, 1921.

an artificial outer harbor of about two square miles, but much of this protected area has limiting depths of 19 feet or less. None of the other lake cities has an outer harbor which could be considered of any commercial importance for ocean-going vessels. The principal river channels, anchorage areas, turning basins, and slips which have been improved to accommodate lake traffic have limiting depths of 18 to 20 feet. Minor channels, smaller basins, and slips used by the smaller lake vessels have limiting depths of 13 to 18 feet.

Finally, it is necessary to take account of the layout of existing port facilities. Grain elevators, industrial and commercial wharves, and railway freight yards are characteristically located back some distance from the lake-front, along the river channels. Warehouses and terminal sheds have been built on the river's edge, parallel to the course of the stream, or they are located on small basins which have been dredged back from the river front. Much of the commercial and industrial development in practically all of the lake ports has of course been built up without any regard to water transportation.

These data are sufficient to indicate in a general way what would be involved in coördinating lake cities with international trade routes. In order to create a large outer harbor and good lake entrance channels to it, miles of breakwater would have to be built and some thousands of acres would have to be dredged. If ocean-going vessels were to penetrate into the inner harbors and serve the existing industrial and commercial inter-

ests, a vast amount of work would have to be done on widening and deepening river channels and turning basins. With deeper channels, existing wharf structures would undoubtedly have to be rebuilt or reinforced. Many new piers would have to be constructed, presumably adjacent to the outer harbor where water frontage would be available. Bridges, street railways, park systems, railway reclassification yards and terminals would in many cases have to be relocated.

We may now indicate the cost of harbor and port development by reference to experience. Liverpool, since 1859, has spent more than $190,000,000 in developing her port.[19] The London Port Authority, created in 1908, paid approximately $112,000,000 for the properties which it took over, and since then it has expended $58,000,000 on further improvements.[20] Glasgow expended $44,000,000 between 1869 and 1909. The development of Boston harbor, exclusive of wharf and terminal construction, has cost $25,000,000.[21] The Federal government has spent approximately $10,000,000 on Baltimore harbor, the city and the State of Maryland have expended about $13,000,000, and the State of Maryland has recently authorized the city of Baltimore to spend $50,000,000 on new public terminals. San Francisco, since 1909, has spent something like $50,000,000 on terminals. New York City has an invest-

[19] *The Accounts of the Mersey Docks and Harbour Board,* 1926.

[20] Owen, D. J., *The Port of London, Yesterday and Today,* 1927.

[21] Data for improvements in United States harbors, except where other sources are cited, are taken from *Annual Reports* of Engineers, U. S. Army.

ment of $30,000,000 in its Staten Island piers alone.[22] Among the lesser American ports, Galveston has spent approximately $11,000,000 on the harbor proper; Jacksonville, $7,000,000 on channel improvements; and Charleston, S. C., approximately $6,500,000. The Alabama State Docks Commission has begun the construction of modern port facilities at Mobile, the ultimate cost of which is estimated at $10,000,000.

While improvements heretofore made at lake harbors have not been on the same scale as those at ocean ports, it is significant to note that a single project costs from one to several million dollars. The Municipal Pier at Chicago cost approximately $4,000,000.[23] The New York State Barge Canal Terminals at Buffalo are costing the state approximately $3,750,000. The Lackawanna Ship Canal, which is a dredged basin 400 feet long, 200 feet wide, and 23 feet deep, extending inland from Buffalo Harbor, cost the Bethlehem Steel Company approximately $1,500,000. The breakwater, which creates Cleveland's outer harbor, cost the Federal government $6,000,000, and the breakwater proposed for Oswego is estimated to cost $7,000,000.[24] Toronto has spent $40,000,000 to date toward carrying out a program of harbor development.[25]

The existing improvements in lake harbors are inconsequential as compared with those required if ocean vessels with a draft of 24 feet are to tie up at the docks of

[22] *The Journal of Commerce*, New York, May 2, 1928.
[23] *The Harbor Plan of Chicago.*
[24] Fay, Spofford, and Thorndike, *Great Lakes Commerce and the Port of Oswego, New York*, 1925.
[25] *Harbour Facts* issued by the Toronto Harbour Commissioners, 1928.

Chicago, Milwaukee, and other lake cities. In most cases lake harbors must literally be created. In addition enormous costs must be incurred in the provision of port facilities and in the reorganization of railway terminal systems with a view to facilitating transshipment to ocean vessels.

There are at least ten lake cities which would have to be included in the plan of harbor and port development, if the route were to serve adequately the commercial interests of Canada and the United States. They are the two upper lake ports, Fort William-Port Arthur and Duluth-Superior, and Chicago, Milwaukee, Detroit, Toledo, Cleveland, Buffalo, Toronto, and Kingston. We believe that the cost of meeting the *minimum* requirements in the way of harbor improvements, port facilities, and terminal reorganizations would reach \$25,000,000 for each of these cities, if they are to become ocean ports in any sense of the word. This would make a total cost of \$250,000,000 for the ten cities mentioned. To develop the lake ports to a point where they could handle the volume of commerce that is contemplated by the proponents of the project, would undoubtedly require expenditures vastly in excess of this sum.[26]

The inclusive costs to the people of the United States and Canada for the development of this transportation agency may now be summarized as follows:

Improvements in the St. Lawrence River	\$257,000,000
Improvement in Lake (channels)	90,000,000
Provision of harbor and port facilities	250,000,000
Total Estimated Cost	\$597,000,000

[26] Improvement of lake harbors would of course also have advantages for purely lake shipping.

To this total must be added the cost of the new Welland Ship Canal, estimated at $115,000,000,[27] which the government of Canada has undertaken, and for which it claims a credit in the allocation of costs for the St. Lawrence-Great Lakes waterway system as a whole. The total capital outlays chargeable against navigation would thus reach approximately $712,000,000. This computation assumes that navigation would bear its share of certain costs which would have to be incurred jointly for navigation and power in the International Rapids and Soulanges sections of the River. If these joint costs were charged wholly to power the total capital outlay chargeable against navigation would be reduced by $98,265,000, making the total costs for navigation approximately $614,000,000.

II. ANNUAL CHARGES

As the second step in our analysis of costs it is necessary to estimate the annual expenditures, on account of transportation, which would have to be met by the United States and Canada for a 27-foot waterway. Annual charges must cover: interest on the capital investment; the annual costs of maintaining and operating canal locks in the St. Lawrence, the Welland, and at the Soo; the annual maintenance and dredging costs for the restricted channels in the St. Lawrence and in and between the Great Lakes; and annual maintenance and upkeep costs for the principal Great Lakes harbors. Since the question of annual charges on the waterway

[27] Interest during construction is not included in this figure.

has not been considered in any of the official reports dealing with the St. Lawrence, we shall have to make our own estimate.

1. *Overhead costs.* In the preceding section the inclusive capital cost of a 27-foot navigation project was estimated at $712,000,000, and the rate at which money could be borrowed on government credit was taken as 4 per cent. Basing computations on these data, then, interest on the capital investment in the 27-foot waterway would amount to about $28,500,000 annually. We shall figure depreciation at the rate of 1 per cent per annum, which would amount to about $7,100,000 annually. The total annual overhead charges thus equal about $35,600,000.

2. *Maintenance and operation.* Since no other existing waterway is closely analogous to the proposed Great Lakes-St. Lawrence development, only a very rough estimate can be given for annual operating and maintenance charges. A consideration of annual operating costs for other navigation projects will, however, indicate the range of annual expenditures involved for the St. Lawrence. The first item to be considered is the cost of operating locks.

The Panama Canal has a total of six locks, as compared with a total of 16 or 17 locks to be operated in the St. Lawrence and the Welland. For the three years, 1926-1928 inclusive, the average expenditure for maintenance and operation on the Panama locks was $1,600,000. A dozen locks on the St. Lawrence route are comparable in lift to those in the Panama. The operation

and maintenance of the present Soo locks costs the governments of Canada and the United States approximately $300,000 annually. It would seem, therefore, that an estimate of $2,500,000 as the annual maintenance and operation costs for the three sets of locks—the Soo, the Welland, and the St. Lawrence—may be taken as conservative.

No satisfactory data are available for estimating the probable cost of maintaining the inter-connecting channels between the Great Lakes and the restricted channels in the St. Lawrence. At the present time the upkeep of the Great Lakes channels, compared with the amount expended on ship channels elsewhere, is very low. For the five years, 1923-1927 inclusive, the average annual expenditure on the channels between Lake Superior and Lake Erie was $252,000. We cite below maintenance costs for a number of other canals and canalized rivers.

The Ohio River—about $2,000,000 annually;
The Delaware River, 63 miles from Philadelphia to deep water—$1,500,000 annually;
The Houston Ship Channel, 50 miles in length—$500,000 annually;
The New York State Canal—$3,500,000 for maintenance and operation, including the locks;
The Panama Canal, 50 miles—about $2,000,000 annually for channel maintenance alone;
The Manchester Ship Canal, 35 miles—about $2,000,000 annually for maintenance and operation combined.

Whether or not the annual cost of maintaining a 27-foot navigation system throughout the Great Lakes and the St. Lawrence would approximate the range of ex-

penditures incurred for maintaining the waterways cited above could only be determined from an engineering estimate of the amount of dredging which would probably be required annually. Nevertheless, certain facts relating to the Great Lakes channels suggest that the annual cost for maintenance of a 27-foot waterway would be very much greater than the cost of upkeep for existing lake channels. There are 150 miles of channel navigation between Lake Superior and Lake Erie compared with the 63 miles of river channel below Philadelphia, or the 50 miles of river navigation which constitute the Houston Ship Channel. To accommodate both lake and ocean traffic the restricted sections of the Great Lakes channels, in addition to being deepened to 27 feet, would probably have to be more than doubled in width. This would inevitably mean a large increase in annual maintenance costs, as the channels to be both widened and deepened are extensive. For example, just below the Soo canals at the upper end of Lake Huron, there are some 45 miles of existing channels, the greater part of which have widths of only 300 feet.

To control lake levels and to regulate flow, the engineers' plans call for certain compensating and regulating works to be developed in conjunction with a 27-foot navigation system. These works would also require some annual expenditures for supervision and repairs. If, therefore, we set down only $1,000,000 for maintenance of the inter-connecting channels between the Great Lakes; and $500,000 to cover the upkeep of the St. Lawrence channels, repairs to compensating works, the

removal of obstructions to navigation, etc., it would seem that we have made a conservative estimate for these items of cost.

The annual cost of maintaining harbors likewise varies with the amount of dredging which has to be done to remove sand bars and the amount of repairs that have to be made to breakwaters. For the five years ending June 30, 1927, the average annual expenditures incurred by the federal government for the maintenance of some of our ocean harbors were as follows: Boston, $37,927; Baltimore, $357,700; Savannah, $62,-408; Pensacola, $31,451; Gray's Harbor, Washington, $121,583; Gulfport, Mississippi, $108,264. Average annual expenditures made during the same period for some of the lake harbors may be indicated: Chicago, $55,219; Milwaukee, $95,346; Toledo, $113,752. In line with these expenditures an allowance of $50,000 per port would seem a reasonable estimate for maintaining 27-foot navigation. Making such an allowance for the ten principal harbors referred to in the preceding section will add another $500,000 to the annual charges for the St. Lawrence system.

In addition to these charges, large additional outlays are required in connection with general administration. For example, at Panama there is an outlay of about $500,000 annually for the marine division, which covers the measurement and inspection of vessels, pilotage, tugs, aids to the navigation, etc. There can be no question that the administration of the St. Lawrence system would cost the Canadian and United States governments not less than $500,000 annually.

Adding together these extremely rough but very conservative estimates, we reach a total of something like $5,000,000 annually as the cost of maintenance and operation of the St. Lawrence-Great Lakes system. This estimate may be compared with an actual average cost at the Panama for the three years 1926-1928 of $6,075,000. Adding $5,000,000 (maintenance and operation) to $35,600,000 (overhead charges) gives a total annual outlay of $40,600,000—in round numbers, $40,000,000.

This sum represents the annual financial cost of the navigation project to the people of the United States and Canada. Whether it is economical or desirable to incur such a cost will of course depend upon the magnitude of the transportation savings which the route would make possible. We must therefore now turn our attention to shipping and traffic considerations.

CHAPTER VI

THE AVAILABLE TRAFFIC

In the light of the shipping analysis presented in Chapter IV, the conclusion was reached that there is grave doubt as to whether any important shipping services would be established over the St. Lawrence deep waterway. In analyzing the traffic problem, we shall however give the waterway the benefit of the doubt and assume that not only would coastwise vessels and trampers enter the Great Lakes, but that a second-rate liner service would also be developed between lake cities and Europe. Two chapters will be devoted to the analysis of traffic possibilities. The first will discuss certain general traffic considerations and present an estimate of the total volume and the classes of traffic that might be expected to use the waterway. The second will consider the significance of the St. Lawrence from the point of view of that particular class of traffic for the benefit of which it has been primarily conceived, namely, agricultural products.

I. WHAT IS INVOLVED IN ESTIMATING TRAFFIC?

A number of studies have been made by agencies sponsoring the St. Lawrence waterway showing that a very great tonnage of traffic would be available for the route. For example, a report prepared by the Great Lakes-St. Lawrence Tidewater Association finds some

30,000,000 short tons as the amount of traffic that would be available as soon as the waterway is opened. A study made by the Transportation Division of the Bureau of Foreign and Domestic Commerce estimates from 18,600,000 to 23,700,000 long tons of traffic available for movement over the St. Lawrence. A critical appraisal of these traffic studies is presented in Appendix C.

Each class of potential traffic presents a special problem for analysis. For example, as to each item of possible export traffic it is necessary to study the precise points of origin, the trade regions and individual countries to which exports move, the alternative routes available, the possibility of return boat cargoes, the months during which exportation largely occurs, the general character of the commodity—whether of high or low value, requiring fast movement and regular time schedules—and methods of sale, marketing arrangements, and established routings. A similar range of considerations is involved in connection with import traffic and also with traffic that might move between the Lakes and the American coasts.

Of particular importance are the methods of sale, marketing, and routing—that is, the general commercial organization that has been built up for the handling of the product in question. For example, automobiles are usually sold in export trade in comparatively small lots which require prompt movement. On the other hand, agricultural machinery is frequently shipped in large instalments to warehouses in foreign countries,

there to be drawn upon with the opening of demand in the planting or harvesting season. Commodities like coal, fertilizer, and china clay do not require speed in delivery and can be warehoused in large quantities, thus rendering them adaptable to water transportation; whereas food products such as fresh meats and bananas require fast movement and special facilities for the preservation of the commodity, thus making movement by rail imperative. In many cases the commercial organization of an industry has come to center in some particular city under conditions which make a shifting of routing a practical impossibility. In other cases accustomed routes can be changed without difficulty.

In endeavoring to estimate the volume of traffic that might use the St. Lawrence waterway, we have undertaken a special analysis of every commodity of any importance which might possibly use the route. The detailed commodity analyses for industrial products are given in Appendices D-J. In making these several traffic analyses we have been fortunate in obtaining, largely by personal interview but in part by correspondence, the assistance of a great many traffic managers in important industrial and commercial establishments, and of official traffic representatives of several of the important cities on or adjacent to the Great Lakes. These traffic managers have informed us as to the factors they face in routing traffic and have explained industrial and trade practices in their relations to this waterway project. In many cases our final analysis of particular commodities has been submitted to representative traffic

men and other specialists for comment and criticism, both as respects the factual data and the reasonableness of the final estimate. It is an interesting and significant fact that the traffic man consulted nearly always expressed strong approval of the project as one of general benefit, but then proceeded to indicate that its advantages from the point of view of his particular commodity were not great. In other words, it appeared to be assumed that the practical difficulties in the use of the route were confined to the particular commodity with which the traffic expert was familiar.

We have, nevertheless, found a considerable volume of traffic, as shown below, which might be expected to utilize the St. Lawrence waterway if it were constructed. The reader should be cautioned against regarding the figures set down opposite the various items of traffic as other than rough estimates. In the nature of the case precision is impossible; and our purpose has been merely to establish the general magnitude and character of the traffic that might be drawn to the St. Lawrence route.

Certain general considerations and assumptions which have had to be kept in mind in making our various traffic analyses should be stated here. First, we have made a distinctly liberal allowance, usually 50 per cent, for growth in the amount of traffic available. (The rated railway traffic growth in recent years has been only about 1 per cent a year; see p. 165.) Second, we have included in our estimates all traffic passing over the present St. Lawrence route, except that mov-

ing very short distances such as sand and gravel. Third, we have included traffic that might move as ballast or at "distress" rates. Fourth, we have assumed that railroad rates will not be lowered with a view to meeting the competition of the water carriers.[1] Finally, as noted above, we have assumed that coastwise vessels would move freely between the Great Lakes and seaboard ports, that tramp vessels would enter the Lakes, and that small cargo liner boats would move on regular schedule between lake cities and European ports.

II. THE VOLUME OF POTENTIAL TRAFFIC

The total volume of traffic classified by commodity groups which might be expected to move over the St. Lawrence waterway is presented in summary form in the table on page 109. We have shown the United States and Canadian traffic separately, and also classified for each country the outbound and inbound tonnage, both foreign and domestic. For the purpose in hand it has seemed desirable to regard traffic moving over the route between the two countries as domestic traffic, such traffic being credited to the country in which it originates.

The table indicates that about 10,500,000 tons of traffic might utilize the route, of which roughly 5,500,000 are credited to the United States and 5,000,000 to Canada. Exclusive of grain, however, the potential traffic assigned to the United States is several times the amount assigned to Canada. A small number of indi-

[1] For an analysis of the basic factors affecting the general level of rail rates during the next decade or so, see Chapter IX.

POTENTIAL TRAFFIC FOR ST. LAWRENCE WATERWAY

(In short tons)

Commodity Group	United States					Canada					United States and Canada
	Foreign Trade		Domestic Trade		Total	Foreign Trade		Domestic Trade		Total	
	Exports	Imports	Outbound	Inbound		Exports	Imports	Outbound	Inbound		
Lumber	....	21,500	......	20,000	41,500	....	....	......	......	....	41,500
Pulpwood and rags	2,500	80,000	......	....	82,500	22,500	4,500	......	......	27,000	109,500
Paper	5,000	10,000	20,000	9,000	44,000	55,000	....	......	1,000	56,000	100,000
Iron ore, iron and steel	188,000	95,000	304,000	50,000	637,000	25,000	100,000	25,000	150,000	300,000	937,000
Manufactures of iron and steel	9,000	5,000	3,500	....	17,500	1,500	....	......	......	1,500	19,000
Machinery and vehicles	283,350	1,400	107,750	....	392,500	42,700	4,100	10,000	......	56,800	449,300
Non-ferrous ores and metals	14,500	14,000	2,000	....	30,500	2,000	15,500	......	......	17,500	48,000
Non-metallic minerals[a]	25,000	396,500	275,000	870,000	1,566,500	10,000	117,250	......	65,000	192,250	1,758,750
Miscellaneous raw materials	6,150	55,750	24,500	1,500	87,900	3,700	26,950	......	......	30,650	118,550
Imported foods	....	50,000	......	450,000	500,000	....	54,500	......	......	54,500	554,500
Total	533,500	729,150	736,750	1,400,500	3,399,900	162,400	322,800	35,000	216,000	736,200	4,136,100
Grain	2,067,000	....	......	....	2,067,000	4,360,000	....	......	......	4,360,000	6,427,000
Grand total	2,600,500	729,150	736,750	1,400,500	5,466,900	4,522,400	322,800	35,000	216,000	5,096,200	10,563,100

[a] Includes 500,000 tons of petroleum. Oil tankers, however, would typically require a channel depth of about 33 feet.

vidual commodities, as shown below, make up the bulk of the total traffic.

Commodities	Short Tons	Percentage of Total Traffic
Grain	6,427,000	60.8
Fertilizers	555,000	5.3
Sugar	500,000	4.7
Petroleum[a]	500,000	4.7
Coal	350,000	3.3
Pig Iron	207,000	2.0
Total	8,539,000	80.8

[a] Contingent upon a channel depth of 33 feet.

For purposes of indicating the character of the shipping problems involved, it will be useful now to classify the total volume of traffic by inbound and outbound movements, and also by regions of origin and destination.

Outbound to Europe	6,798,725
Inbound from Europe	789,250
Outbound to the Orient	135,350
Inbound from the Orient	48,750
Outbound to Latin America	189,325
Inbound from Latin America	204,950
Outbound to Africa	......
Inbound from Africa	8,500
Outbound to Atlantic coast	300 000
Inbound from Atlantic coast	551,500
Outbound to Gulf coast	......
Inbound from Gulf coast	830,000
Outbound to Pacific coast	141,250
Inbound from Pacific coast	20,000
Outbound local[a]	330,500
Inbound local	215,000
Total outbound traffic	7,895,150
Total inbound traffic	2,667,950

[a] The term "local" applies to traffic which both originates and finds its destination along the water route.

Of the total outbound traffic to Europe, 6,427,000 tons is grain and only 371,000 tons is other traffic. The grain movement is highly seasonal, the bulk of it, as we shall see in the next chapter, occurring during the last two or three months of the season of open navigation. The bulk of this grain traffic would, moreover, be carried in lake boats down to Montreal, even though the route were open to ocean vessels. The other export traffic consists principally of machinery, iron and steel manufacturers, automobiles and automobile parts, which together account for about 60 per cent of the total. The import tonnage consists largely of iron and steel and miscellaneous raw materials, such as china clay, wood pulp, coal, and potash. Of the inbound traffic roughly half is of a character adapted to full cargo movement in chartered vessels.

The shipping situation with reference to this traffic may be summarized as follows: Excluding the grain exports which would move in chartered vessels, and such import commodities as would also utilize tramp steamers, we have, roughly, 360,000 tons each of outbound and inbound traffic of sufficiently varied character to be adaptable to liner service. This volume of traffic would require about two boats a week during the season of open navigation, say, one boat from Milwaukee and Chicago, and one from Detroit and lower lake ports. The lower lake traffic would probably be divided between Canadian and American ports. It needs also to be pointed out that these boats would have to go to different destinations—to Great Britain and the channel

ports, to the Baltic, and to the Mediterranean. Thus a fortnightly service between any given lake port and any given European destination would be the most that could be expected. Such a shipping service would be in no wise comparable to that between New York and European ports[2] and would in itself be a factor militating against the use of the St. Lawrence waterway. Whether liner service between the Lakes and Europe would be established for the carrying of this traffic is, as we have shown in Chapter IV, very doubtful because of the problem of finding remunerative winter employment.

Of the export traffic to the Orient, over 60 per cent consists of iron and semi-finished steel products, going mainly to Japan. The bulk of the remainder consists of machinery for various destinations. More than four-fifths of the import traffic is jute from India. There is clearly no balance of outbound and inbound cargo of a varied and general character between the Great Lakes and given points in the Orient which would warrant the establishment of liner service. Such traffic as moves between the Orient and the Lakes would be in the general trader type of vessels.

At first glance it would seem as though the traffic between Latin America and the Lakes is sufficiently balanced and sufficiently large to warrant the establishment of liner service. But detailed analysis shows that of the inbound traffic, amounting to 204,950 tons, 50,000 tons is coffee from Brazil; 40,000 tons is nitrate

[2] See Appendix B for schedule of sailings.

from Chile; 50,000 tons is sugar from the West Indies; 15,000 tons is sisal from Yucatan; and 15,000 is mahogany from Central America. Of the outbound traffic a third is machinery going to widely distributed destinations; about one-sixth is cement to Cuba; and the rest is of a miscellaneous character. Liner service, operating on regular schedule between given ports, or a series of ports, is therefore not likely to develop.

In the trade between the Lakes and Atlantic coast ports, iron ore, pig iron, and semi-finished steel make up 75 per cent of the outbound traffic to cities along the North Atlantic coast; ammonium sulphate *(fertilizer)* and hides and skins account for 24 per cent; and miscellaneous commodities make up the other 1 per cent. Refined cane sugar produced at seaboard refineries accounts for more than 80 per cent of the traffic which would move inbound from the Atlantic coast to Great Lakes territory. The other principal items of potential inbound traffic are superphosphate *(fertilizer)* and scrap iron. Thus it will be seen that the traffic available for movement between Great Lakes ports and Atlantic coast ports is of a bulky character suitable for shipping in small handy sized tramp vessels.

In the Gulf port trade the total inbound traffic consists of three commodities: 500,000 tons of petroleum, 215,000 tons of Florida phosphate rock, and 115,000 tons of sulphur. The oil would, of course, be transported in tankers, which would have no return cargo. The sulphur and phosphate rock are potential tramp traffic, and could be handled either in small coastwise boats, or in

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oversea tramp vessels. We see no opportunity for vessels engaging in this trade to obtain outbound cargoes destined for Gulf ports.

Between the Great Lakes and the Pacific Coast our analysis shows a potential outbound traffic of 140,000 tons, of which 115,000 tons is automobiles and automobile parts, and the remainder is paper and miscellaneous machine products. The bulk of this tonnage would move in industrially owned vessels.

Finally, it is necessary to note the local traffic which would utilize the deep waterway. The commodities which would make up this trade are coal, pig iron, and semi-finished steel. Of our estimate of 330,000 tons of potential outbound traffic, 225,000 tons is coal, orginating at Lake Erie ports for shipment down to Montreal; and 104,000 tons is pig iron and semi-finished steel, originating at lake ports and destined to Montreal. Seventy per cent of the estimated inbound traffic is iron ore, iron and steel, originating at Newfoundland and Nova Scotia, and 30 per cent is coal, also originating at Nova Scotia.

We have a total, then, of approximately 10,500,000 tons of potential traffic for a St. Lawrence waterway, of which approximately 6,500,000 tons consists of grain. We shall not in this chapter attempt to compare the savings in freight rates with the costs of constructing and operating the waterway. That cannot be done effectively until we have considered a number of other phases of the problem. Meanwhile, we turn to a detailed analysis of the importance of the waterway as a carrier of agricultural produce.

CHAPTER VII

THE ST. LAWRENCE WATERWAY AND AGRICULTURAL TRAFFIC *

The agitation for the St. Lawrence waterway in the United States has been based in large measure on the benefits which it is claimed would be conferred upon the farmer. In fact, the project is urged as a major feature in a program for relieving the current depression of the agricultural industry. As indicated in the first chapter, it is contended that the savings each year to the farmers alone would equal the entire capital cost of the waterway. Without critical examination of the validity of the claims, farm journals and many large farm organizations have put themselves on record as endorsing the project. The following quotation sets forth in a broad general way the benefits which they expect this waterway development would confer upon the agriculture of the United States:

> The chief benefit which the United States would receive would be in reducing transportation costs to and from the markets of the world for the vast Middle West section embracing a population of 40 million people. This great inland section is now suffering considerable handicap in competing with coastal regions of the country due to the lack of ocean transportation outlets. Deep water transportation being much cheaper than land transportation would, if brought to the Great Lakes, relieve this handicap now on the people living in the area between the Alleghenies and the Cascades and between

* This chapter has been contributed by Edwin G. Nourse.

the Ozarks and the Canadian border. . . . . With the increasing competition with which their products must contend in European markets, and the distressed condition which confronts American agriculture, the farmers are realizing perhaps more than ever before the need for cheaper transportation costs, and they are urging the completion of the St. Lawrence project as one means whereby substantial savings can be effected and the development of a large area of the nation stimulated.[1]

In this chapter we shall endeavor to ascertain the volume of agricultural exports that would be shipped over the St. Lawrence route and to appraise the probable effect of the route upon the price of farm produce that is not exported.

I. LIVESTOCK PRODUCTS

The assertion has been freely made that exports of packing house products would move in large volume over the St. Lawrence route. For example we read:

Of great importance to the trade of the St. Lawrence are the heavy exports of meats, lard, and other packing house products, which now exceed two billion pounds anually. . . . . Based on production, 73 per cent of these exports originate in the states tributary to the Great Lakes-St. Lawrence ship channel. The exports are destined mainly to the United Kingdom and Europe, but important quantities move to Central America and the West Indies. . . . . Based on the exports of 1922, approximately 630,000 tons are indicated as available for movement over the deep waterway. . . . . As over 530,000 tons of the total of 630,000 tons estimated as available for movement over the waterway moved to the United Kingdom and Europe

[1] Gray, Chester H., Washington representative of the American Farm Bureau Federation, *The Bureau Farmer,* May, 1927, pp. 19-22.

in 1922, the above indicated savings [55 to 85 per hundredweight] would apply on the larger portion of the export movements.[2]

In considering these figures, two major facts need to be taken into account: first, whether the present volume of exports is likely to increase, be maintained, or to decline; and, second, the transportation requirements for these goods.

EXPORTS OF PACKING HOUSE PRODUCTS FOR INDICATED YEARS SINCE 1910

(In thousands of pounds)

Year Ended June 30	Beef and Its Products	Pork and Its Products	Total
1910	286,296	707,110	993,406
1915	394,981	1,106,180	1,501,161
1918	600,132	1,692,124	2,292,256
1919	591,302	2,704,694	3,295,996
1920	368,002	1,762,611	2,130,613
1921	203,815	1,522,162	1,725,977
1922	222,462	1,516,320	1,738,782
1923	194,912	1,794,880	1,989,792
1924	185,372	1,934,189	2,119,561
1925	190,211	1,400,149	1,590,360
1926	152,320	1,172,685	1,325,005
1927	151,531	1,012,668	1,164,199
1928	106,807	1,046,279	1,153,086

There has been a sharp decline in meat and animal fat exports during recent years. The two billion pounds of packing house exports referred to in the above quotation was approximately attained in 1923 and slightly exceeded in 1924, but since that time has been cut almost in half, as indicated in the table on this page.

[2] Ritter, A. H., *Transportation Economics of the Great Lakes—St. Lawrence Ship Channel*, pp. 105-113.

It is by no means certain, in view of the character of current agricultural adjustments in the United States that the present level of exports will be maintained for any considerable future period. However, if we take one billion pounds (500,000 short tons) as the annual figure, or 250,000 tons as the amount moving out during the season when the canal would be in use, and accept the estimate of 73 per cent of the total as derived from territory tributary to the Great Lakes, this would show an outside figure for packing house products amounting to 182,000 tons. As will appear, however, from a consideration of the service requirements of packing house products, this figure of maximum tonnage theoretically available is not of any significance.

Packing house products require special handling and rapid and frequent transportation service. A very substantial part of meat exports consists of hams and bacon destined for the British market. To meet the requirements of this trade the meat must be given a mild cure, and as a result must be handled with the utmost dispatch and with the very finest type of refrigerator service. This means that any lake or ocean vessels which undertook to handle the product would have to be specially equipped, packers being unwilling to risk their product in any and every vessel which might present itself with something which passed as refrigerator service. Indeed, so exacting is the character of this traffic that all the packers who have any considerable part in it own and operate special refrigerator cars which are moved under their own supervision in such a way as to secure the most perfect handling for their product.

This private car system in itself creates a considerable barrier to the use of the St. Lawrence route during the period of the year when it would be available, inasmuch as this special equipment in the form of refrigerator cars, icing stations, and the like would be left partially idle during the summer season. This would involve the loss of the two cents per mile paid the packer by the railroads for the use of these cars while in service. For interior packers (some of whom are large factors in the business) there would be also the delay and risk of reloading at the lake port. One of the most important of the interior packers expresses himself as feeling that this would be a serious drawback in the case of high-grade, mild-cured products[3] which they handle. It could of course be obviated by so extending railroad terminals that refrigerator cars could be delivered at ship-side, but it is doubtful whether the volume of traffic requiring such service would be large enough to encourage the railroads to undertake improvements which would involve so much expense. In the case even of packers located in lake port cities, the cost of trucking from their plants, which are located on railroad lines several miles from the docks, would involve an expense and also a

[3] "Since the bulk of export hams are in the sweet pickled form, a special method of treatment has been developed for handling them, so that they will be under uniform temperature. They are maintained at this temperature in refrigerated rooms during curing, are packed and boxed for shipment in the same rooms, and are transported to the seaboard in refrigerator cars at a constant temperature. At the seaboard the cars are loaded onto ferries which are drawn up alongside the receiving steamships and are transferred directly from the cars to the refrigerated space aboard." *Monthly Letter to Animal Husbandmen,* Armour's Livestock Bureau, September, 1927, p. 9.

serious drawback to handling their perishable commodity during the summer months when the water route would be open. Indeed, one large Chicago packer points out that this seasonal consideration goes far toward making packers skeptical of the feasibility of using at all the longer haul over the Great Lakes, whose summer temperature is much higher than that over the ocean.

From many points of view, the time element is paramount. Besides the danger of deterioration already mentioned, there is the higher cost of refrigeration for the longer period, a small item for added interest on the capital tied up in the shipment, and a very serious consideration as to impairment of the flexibility of marketing arrangements. A large proportion of packing house products consists of very perishable commodities which cannot advantageously be accumulated in storage against the filling of future orders over any considerable period of time. The packer desires to keep his finger on the pulse of a fastidious and rapidly fluctuating market and to dispatch his shipments with the utmost speed to make close connections with ocean sailings and to effect the shortest journey to his customer.

One of the most important of the export packers sums up this phase of the matter as follows:

> As the amount of time between our packing plants and final destinations in Europe is of the utmost importance, even two or three days would make quite a difference to us—seven to ten days is simply out of the question. . . . . Time is the essence of our contracts with our patrons and connections on the other side. We seek always to speed up the movement of

our product rather than to decrease it, and this is very essential on account of the fact that perishable foodstuffs, such as we deal in, are subject to violent market fluctuations. This is truer today than it has ever been before, owing to the fact that on July 1, 1927, the British government prohibited the importation of packing house products cured, prepared with, or packed in, borax or similar preservatives. The use of borax had made it possible to ship mild-cured packing house products on slower boats and in higher temperatures than are now possible. Whereas formerly we were able to ship our products in borax by slower boats and store them in warehouses abroad against the rise and fall of market conditions, we are now able to do practically a hand-to-mouth business only, and the holding of meats on the other side in cold storage has practically been abolished.

The unanimous testimony of those directly concerned in this field appears to be that the availability of the St. Lawrence waterway for the transportation of packing house products would be limited to the non-perishable items such as lard, neutral lard, dry salt meats, baled hair, and miscellaneous by-products. Even admitting, however, the suitability of the St. Lawrence route for the transportation of these less perishable items, it must be remembered that in many cases these products are going to the same consignees as are the perishable products as part of a mixed order, and for convenience in handling and also as a matter of filling out carlots it would be much more practicable to send them by rail to Montreal, New York, or other seaboard port than to attempt to take advantage of such savings as were available by shipping via the Lakes from Chicago or Milwaukee.[4]

[4] "The members of the Traffic Committee [of the Institute of American Meat Packers] feel but little interest in the proposed waterway because: (1) with perishable products such as

Hence it would seem reasonable to estimate that the tonnage of packing house products which might conceivably use the St. Lawrence route could not possibly exceed

ESTIMATED WEIGHT OF PACKINGHOUSE PRODUCTS AVAILABLE FOR THE GREAT LAKES-ST. LAWRENCE ROUTE, 1926-27 [a]

(In pounds)

Commodity	Total Exports	Exports for Summer Months	Estimated Fraction Available
Least perishable beef products [b]	143,446,000	72,994,000	38,497,000
Least perishable pork products [c]	745,144,000	372,091,000	124,030,000
Mild-cured pork products [d]	271,192,000	149,281,000	7,464,000
Total in pounds	. . . .	. . . .	167,991,000
Total in short tons	. . . .	. . . .	83,995

[a] Compiled from *Monthly Summary of Foreign Commerce*, Part I, December, 1926, and June, 1927.

[b] Includes pickled or cured beef and veal, canned beef, oleo oil, oleo stock, tallow, oleo and lard stearin, oleomargarine of animal or vegetable fats.

[c] Includes pickled pork, canned pork, canned sausage, lard, neutral lard, lard compounds (contain animal fats).

[d] Includes Wiltshire sides (shoulder, side, and ham), cured hams and shoulders, cured bacon (sides and backs), Cumberland sides (shoulder and side, ham off).

one-half the total summer shipments of semi-perishable beef products, one-third the summer shipments of lard and other less perishable pork products, and a very

form the bulk of packing house exports time is of extreme importance; (2) the St. Lawrence waterway would be closed during the five months which form the main export season for packing house products; (3) new regulations of the British Ministry of Health make it necessary to ship meats from North America without any preservatives such as at present may be used and, for this reason, even more prompt shipment and transport than have been customary up to the present for packing house products will be imperative." Letter to the Institute of Economics from the Department of Public Relations and Trade of the Institute of American Meat Packers, September 17, 1926.

small portion, possibly 5 per cent, of the mild-cured pork products. This would amount at the present level of export to some 84,000 tons annually, as shown in the accompanying table. This traffic, however, would develop only in case a first class liner service with frequent sailings and good refrigeration facilities were provided. Since our analysis of the shipping problem[5] indicates that no such service is likely to be available, we must conclude that packing house products would make but a negligible use of the St. Lawrence route.

Dairy products likewise present little prospect of furnishing an important item of traffic. Were boats available on the Great Lakes with refrigerated chambers suitable for carrying the semi-perishable packing house products just mentioned (notably lard and lard substitutes), they would be equally suitable for the carrying of butter. However, the dairy farmers of the United States are not looking forward to entering the export butter market, where competition is already keen, if not ruinous, between such dominant export countries as Denmark and New Zealand, with promise of considerable increase not only from these sources but also from Argentina, and from Russia at that problematical date at which her agriculture will have achieved its naturally-to-be-expected recovery. At the present time, the problem of our dairy industry is distinctly that of holding tariff rates on butter high enough to check the inflow of foreign supplies while at the same time effecting such an adjustment of production as to supply domestic

[5] See Chapter IV.

needs without accumulating an export surplus. Butter exports have in recent years averaged about 5 million pounds, most of which moves to tropical and Oriental markets and would thus be at best a negligible item in the St. Lawrence traffic.

The same general conclusion may be drawn with reference to cheese and condensed and evaporated milk. The latter commodity rose to the rather impressive figure of over 700 million pounds of export in 1918-19 and 1919-20, but dwindled to 109 million pounds in 1927-28. It does not seem likely that this trend will be reversed or that the United States will become a supplier of dairy products to Europe in quantity sufficient to contribute an important traffic to the St. Lawrence waterway. The competition is too keen from Denmark and other European dairy producers, or from competitive sources overseas, notably New Zealand. And even were the United States to become a dairy exporter on a considerable scale it must be remembered that these products are all of high value in proportion to their bulk and less dependent on minor differences in the transportation rate than are cheaper and bulkier commodities.[6]

II. GRAIN TRAFFIC FROM THE UNITED STATES

Grain exports constitute by far the largest single item of potential waterway traffic, and it is sometimes as-

[6] The discussion of this section has related entirely to the United States. While Canada has a small export movement in livestock products, their origin is in the eastern provinces and practically no movement by the waterway is indicated.

serted that they alone would justify the construction of the St. Lawrence ship channel. It has been estimated that 597 million bushels of grain would move over the waterway,[7] of which 333.1 million bushels are produced in the United States and 263.9 million bushels in Canada. We may conveniently examine these figures first with reference to the United States and later analyze the Canadian situation separately.

Aside from wheat, the cereals do not offer important traffic possibilities for the St. Lawrence. Corn, which is the largest single element in our cereal production, is insignificant as an export item—about one-half of one per cent of the total crop. Furthermore, of even the small amount of corn which does move out of the country some 46 per cent goes to Canada and another 30 per cent to Mexico, Central and South America, and Cuba. Owing to the lateness of the date at which corn is harvested, less than half our exports move out during the months of open navigation. Furthermore, it is a notorious fact that corn, unless extremely sound and dry, has a great tendency to go out of condition when subjected to a long journey stored in large bulk in a poorly ventilated space such as the hold of a ship. This and other commercial considerations make it doubtful whether any of our slight corn export would go by the waterway even though it were to offer a nominal saving in transportation charges. But assuming that half of the summer movement of the corn exported to European

[7] Ritter, *ibid.*, p. 215. In a second table on the same page, the total is set at 525 million bushels.

destinations were to find its way through the St. Lawrence waterway, this would mean only about one million bushels, or 28,000 tons, annually.

Rye exports, on the other hand, move largely from northern ports. While Canada is the nominal destination of some two-thirds of the total, much of this is re-exported. Hence we may assume that 75 per cent of the export tonnage of this cereal which goes out from Great Lakes and North Atlantic ports during the summer months would benefit by whatever saving in rates might be effected. Average rye exports from these customs districts for the months May to November,[8] inclusive, during the last three years amounted to 15.6 million bushels. Seventy-five per cent of this would be 11.7 million bushels—the possible rye traffic for the waterway.

Barley is not a large item of export from the lake region, since more than half of our exports originate in the Pacific Coast states, chiefly California, and are exported from San Francisco. On the other hand, barley is harvested early in the season, and nearly three-fourths of the exports move during the seven months of open navigation. Likewise, there has been an increase in barley exports during recent years. If we assume that a low-cost water route would draw traffic away from the North Atlantic ports to such an extent that 60 per cent of present summer exports were secured, this would amount to 6.7 million bushels.

[8] We take seven full months instead of six months and a half as the period in the case of grain because the lake grain boats would doubtless move down to Montreal until the actual closing days of the navigation season.

Oats are one of our minor export cereals and move through North Atlantic ports in much greater volume even during the summer time than from Great Lakes and St. Lawrence ports. If there were to be such a marked shifting from the North Atlantic ports to the St. Lawrence waterway that the latter would secure two-thirds of the traffic during the period of open navigation, this would, on the basis of present export movement, amount to only 12.2 million bushels yearly.

Wheat overshadows all other cereals in our export trade. The movement abroad averages about 200 million bushels, figuring flour on the grain basis. It must be distinctly borne in mind in this connection, however, that the Great Lakes territory is only one of four exporting regions which contribute to this total. The Pacific Northwest and the Gulf Southwest will continue to export through their nearby water outlets. Likewise, a considerable interior region, reaching roughly from Missouri east to Pennsylvania and Virginia, will continue to market its wheat to nearby mills or local markets, with such surplus as eventually gets into the export trade moving in large part eastward to the Central Atlantic markets by routes not sensitive to theoretical water competition.

The wheat territory chiefly tributary to the Great Lakes is one of declining rather than increasing importance as an export surplus area. Acreage figures for the region (16 states[9]) declined from 75.7 million in 1919

[9] Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Montana, Wyoming and Colorado.

to 45.9 million in 1928. The decline has been substantial in all the eastern part of the section, including Minnesota, but offset in part by increases in Montana and North Dakota. The states comprising the eastern half of this group even now constitute a wheat deficit area, as shown by the following calculation. The wheat production of Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa, and Missouri averaged 130.2 million bushels for the last three years. The population of these seven states as estimated by the Bureau of the Census for July 1, 1928, was 30,893,000. Under the customary estimate that food, feed, and seed requirements average about 5.6 bushels per capita, the annual consumption of the states in question would be 173.0 million bushels, resulting in an annual deficit of 42.8 million bushels.

The progress of general farming has been operating to remove more and more of the one-time wheat region from an export surplus position, and it is not until we enter the second tier of states west of the Mississippi River that we find the important surplus region. Even Minnesota's surplus amounts to only 8 million bushels, which does not offset the deficit of the seven states already discussed.[10] Furthermore, the hard spring wheat of the Northwest states meets a special milling demand which consumes all of the better grades and calls occasionally for Canadian imports even over our present

[10] This of course does not mean that no wheat is actually exported from these states. The contribution of Minnesota, Indiana, and Illinois is substantial, although it is only in the case of the first of the three that it has a considerable significance for lake transportation.

tariff wall and to a much greater extent draws shipments from the hard winter wheat region of the Southwest. It is chiefly in the case of durum wheat and miscellaneous lots of the lower grades of milling wheats of this Northwest section that this territory now figures as an exporter. The indications are that the export movement will continue for a time, but on a scale of descending rather than increasing importance.

The Southwest cannot be counted on to furnish any large tonnage to the Great Lakes route. It is now and will apparently continue for some time to be a heavy exporter of wheat, but Gulf ports offer the most economical shipping outlet for the southern part of this territory, and interior mills, particularly in Kansas and Missouri, convert a large amount of the wheat of this remote inland section into flour and other finished products for domestic consumption. It is true that traders at St. Louis, Kansas City, and other points accumulate round lots of grain such as may, when occasion offers, be sold to exporters at Chicago, Buffalo, or Montreal, and that this movement would be somewhat increased by any reduction which might be brought about in all-water export rates. On the other hand, the tendency of wheat production in this region is toward migration farther and farther to the southwest, away from the reach of the Great Lakes route and toward the region naturally tributary to Gulf ports.

This movement of the wheat belt falls into step with a similar migration of cotton growing from the Southeastern states to west Texas, which in turn tends to

strengthen the hold of Gulf shipping on the export movement of wheat from the important Southwest producing territory. The reasons for this are as follows: The west Texas cotton moves naturally by the shortest rail haul to the Gulf ports, and has brought about an increase in the export cotton movement from Galveston alone amounting to over 3 million bales annually in the period since 1920. This port handled in 1927 more than one-half of the total exports from the United States. Cotton is a relatively light-weight cargo which, because of its high value in proportion to bulk, commands a fairly remunerative rate, but needs to be supplemented by a much heavier "bottom cargo" which will contribute to the proper ballast of the ship. For this purpose wheat is excellent, and the large and growing fleet of cotton vessels thus create a permanent outlet for wheat of the Kansas-Oklahoma surplus region, which assures the continued use of that route.

A considerable volume of grain will be taken by Atlantic ports at rates which defy competition. The situation there is akin to that just discussed for Galveston. "Grain is very desirable deadweight cargo for liners, and it has been generally recognized that the interests of shipping render it undesirable to include grain rates among those rigidly fixed by conference, because of the fact that vessels must be left free to compete for grain which they need for loading."[11] As a result, a considerable amount of grain tonnage can be moved from North Atlantic ports during the summer season at rates which are only half

[11] *Transportation on the Great Lakes,* The Board of Engineers for Rivers and Harbors, U. S. War Department, p. 87.

or even a third of the winter rates.[12] The amount of shipping which enters the North Atlantic ports primarily for the sake of passenger and package freight is at its peak during the summer months when (up to September) grain movement is below its maximum. This combination of circumstances leads to many opportunities for disposing of grain cargo on extremely advantageous terms.

It is clear from the various traffic considerations which we have been discussing that only a portion of the total wheat exports of the so-called tributary producing areas would find it advantageous to use the St. Lawrence waterway. In attempting to arrive at an estimate of the amount which might utilize the waterway, it is necessary to examine the actual present movement from the customs districts of the Great Lakes and St. Lawrence River region and from North Atlantic ports.

During the seven-months period from May to November, inclusive, the export movement of wheat from the Great Lakes and St. Lawrence River customs districts has fluctuated during the last six years from about 18

[12] For instance, the War Department *Report* on the Port of New York (Port Series, No. 20, Part I, p. 339) shows a monthly average rate on heavy grain of 6 cents per hundred weight in August and 5 cents in September, 1923, as compared with 15¾ cents in November and 16 cents in December. The same table shows numerous instances of rates to other ports not in excess of 7 cents per hundredweight. For the current season the weekly freight report and list of charters published by a prominent firm of steamship agents and ship brokers in New York shows rates during the latter part of June and through July of 6 and 7 cents to Hamburg, Rotterdam, and Amsterdam. On a bushel basis this would bring rates to two to four cents as a minimum.

million bushels in the smallest year to 51 million bushels in the largest, an average of 33 million bushels a year. All of this, we shall assume, would utilize the St. Lawrence waterway. The movement from the North Atlantic ports during the same period has ranged from 27 million to nearly 58 million bushels, averaging 36.6 million bushels. To assume that one-third of this summer movement from North Atlantic ports would be diverted to the St. Lawrence waterway would seem liberal, in view of the competitive conditions in this territory which have been discussed above. The total of this wheat movement is, as we have seen, rather likely to decline.

If we take, therefore, 12.2 million bushels as the amount which might be diverted annually to the St. Lawrence and add it to the 33 million bushels moving out from Great Lakes and St. Lawrence River customs districts, the volume of wheat available to that route annually would stand at 45.2 million bushels, and the total traffic for the five principal grains would amount to about 77 million bushels, estimated as follows:

	Million Bushels
Corn	1.0
Rye	11.7
Barley	6.7
Oats	12.2
Wheat	45.2
	76.8

Translating bushels into tons, we have a total of 2,067,600 tons as the total American grain traffic that might use the St. Lawrence waterway. This figure is based on present production and exports. We have shown

above that the tendency is for the export of grain from this territory to decline and perhaps ultimately to disappear. However, in view of some uncertainty as to the rapidity with which this decline will occur, we shall let the present figure stand, thereby giving the waterway the benefit of every doubt.

III. THE CANADIAN SIDE OF THE PICTURE

We turn now from the United States to Canada, which also has a large interest in the proposed development

CANADIAN GRAIN PRODUCTION, 1922–1928 [a]

(Millions of bushels)

Year	Wheat	Oats	Barley	Rye	Flax
1922	399.8	491.2	71.9	32.4	5.0
1923	474.2	564.0	77.0	23.2	7.2
1924	262.1	406.0	88.8	13.8	9.7
1925	411.4	513.4	112.7	13.7	9.3
1926	400.8	383.4	99.7	12.1	6.0
1927	440.0	439.7	96.9	15.0	4.9
1928	500.6	437.5	134.5	14.6	3.5

[a] *Report on the Grain Trade of Canada*, Dominion Bureau of Statistics. The figures for 1927 and 1928 are taken from the *Monthly Bulletin of Agricultural Statistics*, Dominion Bureau of Statistics, November, 1928.

of the Great Lakes route. Her potential agricultural traffic is limited to grain even more exclusively than that of the United States. The chief difference is that corn does not figure in the totals, whereas flax is a somewhat important item.

Canadian cereal production, as the table above shows, has been increasing in recent years. The Prairie Provinces are one of the world's great surplus areas, and

exports of the five principal grains have exceeded 400 million bushels twice in recent years. The table which follows shows the total volume of exports during the past seven years, and also the distribution of these exports according to the four principal routes followed.

CANADIAN EXPORTS OF FIVE PRINCIPAL GRAINS [a]

(In millions of bushels)

Year Ending July 31	To U. S. Ports Direct	To Other Countries			Total
		Via U. S. Ports	Via Canadian Atlantic Ports	Via Canadian Pacific Ports	
1922 [b]	23.8	131.8	75.6	9.2	240.4
1923 [b]	18.8	172.9	116.2	21.7	329.4
1924	30.8	195.9	124.5	60.8	412.0
1925	9.0	135.7	97.9	27.1	269.7
1926	14.0	194.6	136.4	59.2	404.2
1927	11.5	181.3	111.8	45.4	350.0
1928	11.8	175.4	103.8	94.2	385.2

[a] Wheat and wheat flour, barley, rye, oats and oatmeal, and flaxseed.

[b] Oatmeal not included. It would add 2.9 million bushels to the total in 1922 and 2.0 million bushels in 1923.

The small movement of grain into the United States for consumption here in spite of our protective tariff would presumably remain unchanged by the opening of the St. Lawrence deep waterway. Much the same can be said concerning the movement via Pacific ports of Canada, although proponents of the waterway argue that increased facilities and lower rates eastbound would draw grain to that route which now moves to the Pacific Coast. This contention is weakened by the fact that an important fraction of the Pacific Coast movement

is for Oriental consumption and is made up of types of grain which do not find a favorable market in Europe, and still more by the fact that these ports can operate during the winter months when the St. Lawrence route is closed. The growth of this trade was retarded by the time required for constructing handling facilities and developing trade connections and organizations. It is noticeable, however, that the movement of the last year far exceeds that of any previous year.

About four-fifths of Canada's overseas movement is from Atlantic ports of Canada and the United States. Those who discuss the future of the St. Lawrence waterway often assume that all this grain would use the St. Lawrence route. Several exceptions, however, must be taken to this view. The first and most obvious is that Canada is even now busily engaged in constructing a railway to connect with ocean vessels on Hudson Bay. (See map on page 192.) This route is designed to draw grain from the northeastern part of the prairie grain-growing area and will no doubt to some extent divert traffic from the St. Lawrence. Owing to the extreme northern latitude of this route, it will be available for only a short period—somewhere from 10 to 15 weeks—and it has been estimated that its capacity will not exceed 16 million to 24 million bushels of grain annually.[13]

A second exception to be made to the proposition that the Canadian grain which now moves out through United States ports would, upon completion of the waterway,

[13] Smith, W. Nelson, "An Economic Examination of the Hudson Bay Rail Project," *The Engineering Journal* (Canada), June, 1924, p. 272.

be diverted to that route, grows out of a somewhat technical consideration of the actual character of the grain movement. It must be remembered that the harvest dates in the prairie provinces are comparatively late, and there is a tremendous peak load of late grain traffic in September, October, and November. It is commercially desirable to move the late harvested grain of the Canadian prairie provinces sufficiently forward toward the market so that it can be handled advantageously during the remainder of the marketing season, but this does not necessarily mean that it would be desirable to complete the export movement of the crop immediately after harvest. In terms of cost of storage and of efficient distribution, both geographic and in point of time, it is better that the flow of grain move somewhat more slowly through the primary and secondary markets. This means that it is desirable for a considerable amount of grain to get into mill or storage elevators at Buffalo, or be stored (as is the practice) in lake boats during the months following the close of navigation, and for much of it to pass in the form either of grain or of flour into export trade during the winter and spring months as advantageous marketing opportunities appear. The European grain market ordinarily shows a seasonal advance in April and May after the southern hemisphere crop has been disposed of. This occurs at a time earlier than the resumption of water transportation on the Lakes; and the movement through Buffalo and our North Atlantic ports permits even the Canadians to take advantage of the customary spring rise in price.

Furthermore, Canadian grain is desired by American exporters for blending on shipboard with American grain as a means of bringing up some of their off-grade export surplus to merchantable European grades.

These several considerations mean that a substantial though indeterminate fraction of the product now moving through United States ports would continue to find its most advantageous commercial outlet through this channel even through a St. Lawrence waterway adequate to carry all grain that might be offered at the peak movement were available.[14]

It would seem that the most liberal estimate which we could justify of the amount of Canadian grain now moving via United States ports but which might be diverted to the St. Lawrence waterway would be one-fourth of the total annual movement. We have shown that even now a sizeable portion of the Canadian exports move via United States ports even during the summer months, and also that there are valid commercial reasons for continuing the orderly market movement of the grain through the winter months rather than accentuating further its seasonal peak. If one-fourth of the grain which now finds it commercially advantageous to move

[14] The fact that a commercial pull draws Canadian grain to United States ports even when Canadian ports are open is shown in the statistics of monthly distribution of the export movement furnished by the Dominion Bureau of Statistics. This was particularly noticeable during the past year in which 15.5 million bushels of wheat were exported via United States ports in May, 12.3 million in June, and 27.3 million in July, as compared with 2.7 million, 9.6 million, and 11.4 million, respectively for Canadian Atlantic ports during the same three months. Obviously, this grain was not forced through United States channels by reason of the congestion on the Canadian route during these months.

through the United States were to be thus diverted and added to that moving through Canadian ports during the seven summer months, it would make a total of some 155 million bushels. From this figure, however, we must deduct the amount which will move over the Hudson Bay route—say 20 million bushels.

On the other hand, we must allow for possible growth of production and export from Canada in the years ahead. We have noted earlier that the grain acreage of Canada has been expanding rapidly; and the possibilities of further expansion have by no means been exhausted.[15] The economic urge for such expansion, however, is much weakened by the keen competition of other important grain-producing countries and the not too attractive level of grain prices, present and prospective. Hence, an estimate of 20 per cent of further increase would be liberal. Should it in fact be realized, it would bring the total Canadian grain movement over the St. Lawrence waterway up to a

[15] "In short, Canada has large potentialities for increase in wheat acreage . . . . Expansion will probably be stimulated by a level of wheat prices even lower than that which prevailed in 1924-25, and once made, increases are not likely to be reversed. It will be moderated by the prospect of the return of Russia as an important competitor in the world's markets and by the fact that the new lands available for wheat culture are on the whole less favorable than those previously devoted to wheat. The average yield of wheat in the next few years is not likely to reach the high levels of pre-war days, and may decline still more unless diversified farming develops and maintains yields by good methods, at the expense of larger acreage. Canada's wheat crops and wheat exports will continue to fluctuate greatly from year to year. On the average, both may be expected to increase over the next few years, but it is doubtful whether Canada's average exports will increase in the next ten years by more than 100 million bushels over the average of 1920-24." *Wheat Studies of the Food Research Institute,* Vol. I, No. 8, p. 272.

possible 162 million bushels.[16] This is the equivalent of about 4,360,000 tons.

IV. PROBABLE REDUCTION IN FREIGHT RATES

Estimates have differed somewhat as to the extent to which transportation rates[17] might be reduced by the opening of the St. Lawrence waterway. Average figures of 8 or 10 cents have been freely quoted, and the Great Lakes-St. Lawrence Tidewater Association submits as many as nine separate estimates ranging from the smallest classification, which includes 5 million bushels at a calculated saving of 4½ cents, to the largest classification, which includes 190 million bushels at 11.8 to 12.1 cents per bushel.[18] Several steps in the method by which these figures were arrived at are not made clear, but it is evident that the estimated saving is exaggerated by at least two faulty assumptions.

[16] We are not overlooking the fact that there might be some tendency to divert to the waterway grain which now moves over the Canadian railways, chiefly during the period of closed navigation. Aside from commercial reasons against this seasonal readjustment, and the fact that a portion of the Canadian crop cannot be hauled from the farm or in some cases even threshed until the following spring, there is the question of policy on the part of the Canadian government. The Canadian National Railways are a government enterprise no less than the proposed waterway would be. Could the Canadian government afford to lose grain traffic from roads already suffering from insufficient traffic? This question is discussed in Chapter IX.

[17] We use the term "rates" rather than "costs," because the rates to be charged cover only the direct costs to the shipowners incurred in moving traffic; the enormous overhead costs for construction and maintenance of the waterway are to be borne by the taxpayers. (See Chapter XI.)

[18] Ritter, *ibid.*, p. 215. This is about 45 per cent Canadian and 55 per cent American grain. For an appraisal of Mr. Ritter's general traffic estimates, see Appendix C.

The first false premise is that ocean vessels would enter the Lakes and carry grain at rates which would exceed present ocean rates only by an amount proportional[19] to the added length of the run. The analysis of the shipowner's problem presented in Chapter IV of this book has shown that the extension of an ocean vessel's run into the Great Lakes would involve increased navigation hazards and a 25 per cent reduction in average sailing speed. Inbound cargoes would, moreover, usually be difficult to secure. (See proportion of outbound and inbound cargoes, p. 110 above.)

Mr. Ritter says, "with a rate of 8 cents per bushel to Liverpool from North Atlantic ports . . . . a reasonable rate from the Great Lakes direct will be 10 cents per bushel."[20] As a matter of fact, grain rates out of Montreal to British ports have run about 10 cents per bushel during the busy fall seasons of the last few years.[21] With a distance 40 per cent as great, reduced speed, and added insurance costs, the rates from upper lake ports to Montreal would have to be at least half those

[19] Indeed less than proportional, since their estimate adds only 20 per cent to the Montreal-Liverpool rate, whereas the added distance to Chicago is 39 per cent and to Duluth is 44 per cent.

[20] *Ibid.*, p. 162.

[21] Montreal-Liverpool charter rates, September to November, inclusive, ranged from 2/9 to 3/6 per quarter in 1925, from 3/1 to 3/6 in 1927, from 2/6 to 4/– in 1928. The rates in the fall of 1926 were so abnormally enhanced by the British coal strike that we will disregard them. Converting these quotations to American money and measures, they would average 9½ cents per bushel in 1925, 10 cents per bushel in 1927, and 10½ cents per bushel in 1928. See *International Yearbook of Agricultural Statistics* (Monthly International Crop Report and Agricultural Statistics of the International Institute of Agriculture).

The reasons for using tramp rates during the autumn months will be evident from the discussion on pages 147-149.

from Montreal to Europe. This means 15 cents per bushel instead of 10 cents used in the estimates by Mr. Ritter for the Tidewater Association.[22] If liner service were established between Chicago and Liverpool, some grain might be sought as bottom cargo at rates somewhat lower than this figure. Such reductions in rate would, however, not apply to any considerable proportion of the total Canadian and United States grain movement.

The second fallacy in the method by which savings of 8, 10, or even 12 cents are credited to the proposed waterway grows out of the competitive rail and water rates which are taken for purposes of comparison. Mr. Ritter compares existing all-rail and combination rail-and-lake rates to the Atlantic seaboard from remote interior points such as Oklahoma City, Wichita, Wiggins (Colorado), and Columbia Falls (Montana), with the assumed combination rate from these interior points via the St. Lawrence. It would be a much sounder method to make a comparison of existing rates from Duluth and Chicago for grain now moving down the Lakes to Buffalo and thence by rail to New York, and of grain moving by an all-water route through the existing St. Lawrence canals to Montreal. This recognizes the fact that grain must continue to move by rail from interior

[22] The United States Department of Commerce estimates rates of 8 to 11.2 cents per bushel and savings of 6.4 to 9.6 cents per bushel. Their methods include the same fallacies as those discussed here and other defects also. For example, examination of the very figures cited in the report reveals that, by entering the Lakes for grain, vessels would *lose* from 2.7 to 6.5 cents per bushel. See *Great Lakes-to-Ocean Waterways,* Domestic Commerce Series, No. 4, U. S. Department of Commerce.

points to the head of the Lakes were the canals enlarged, precisely as it has now to move by rail to Duluth, Chicago, or other ports; and there is no reason to suppose that the rail fraction of the joint export rate would be altered by the St. Lawrence waterway development.

Lake and rail freights on wheat from Chicago to New York ranged from 10.6 to 11.6 cents per bushel during the season of 1927 and from 10.73 to 12.85 cents in 1928.[23] The average for the season has ranged from 10.87 to 12.19 during the last five years, being 11.36 cents in 1928. From Duluth, lake-and-rail rates to New York were substantially the same as from Chicago, though tending to run a fraction of a cent higher. The all-water rate from the head of the Lakes to Montreal has ranged from an extreme low point of 6 cents to an autumn peak of 12 or 12.5 cents, but is generally computed at 9 cents as the season's average.

We have shown 10 cents to be the approximate cost of water transportation from Montreal to Great Britain. From New York, with its keen competition for grain and the greater importance of berth as compared with charter rates, 8 cents is a roughly accurate figure. This is the rate used by Ritter, while Gregg and Cricher use 7.6 cents.[24] A trans-Atlantic rate of 8 cents plus a lake-rail rate of 11.1 cents would give 19.1 cents as the present cost through New York. Our fall rate of 10 cents from Montreal to Liverpool should be reduced perhaps to 9.5 cents as a season's average. This,

[23] Chicago Board of Trade *Annual Reports,* 1927, 1928.
[24] U. S. Department of Commerce, *Great Lakes-to-Ocean Waterways,* p. 65.

plus 9 cents as the generally accepted water rate from Duluth to Montreal, gives us 18.5 cents as the comparable Montreal rate.

The actual freight rate via the Great Lakes-St. Lawrence waterway will be determined by the competition of existing Great Lakes carriers. Grain transportation on the Great Lakes is dominated by the large bulk cargo carriers, which afford the most efficient and economical method of transporting grain that has thus far been devised. There is every reason to suppose that once adequate facilities were provided for extending their present run from Buffalo or Port Colborne to Montreal, lake carriers would retain their present grain trade and absorb a large part of any expansion which might occur as a result of the diversion of grain from rail routes to the waterway. The lake boat is an enormous cargo-carrying shell, requiring but small space for fuel bunkers or quarters for the crew, and built without upper decks. It can be loaded and unloaded with a maximum of speed and economy,[25] and needs but a small crew to operate it.

[25] "The modern bulk freighter is the most interesting type of ship navigating the Great Lakes. The enormous volume of traffic in bulk freight to be transported in a limited navigation season created a demand the response to which is the bulk freighter of present-day design and proportion. These vessels are constructed to standards which permit of greatest efficiency in loading and discharging cargo. As a class, they are the most economical carriers of bulk freight yet devised. The typical bulk carrier has its power plant far aft and its quarters in the extreme forward end. All the space lying between is unobstructed cargo hold. . . . . There are no bulkheads or compartments in the hold. . . . . The grain loading record is held by the steamer *West Mount* which, on October 31, 1921, loaded 355,000 bushels from the Saskatchewan elevator at Port Arthur in five hours. Another record of interest is that of the steamer *Wm. L. Brown* which, on November 23, 1923, loaded 130,000 bushels of wheat in 60 minutes, a rate of 2,166 bushels per minute. . . . . An unloading record for grain was established at

These boats [26] are able to transport grain from the head of the Lakes to Buffalo, a distance of 1,000 miles, at a cost of approximately 3 cents per bushel.[27]

The lake fleet is adequate to present needs and could be quickly expanded to handle any additional grain which would go down to Montreal. Julius H. Barnes has estimated that the grain cargo boats of the Lakes could extend their present 1,000-mile haul, terminating at Buffalo, to a 1,350-mile haul, terminating at Montreal.

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the Terminal Elevator at Buffalo in 1917, when the steamer *Shenango* unloaded 451,382 bushels of wheat in fifteen hours." *Transportation on the Great Lakes*, Board of Engineers for Rivers and Harbors, U. S. War Department, pp. 33-34.

[26] See discussion, pp. 39-47, above, as to why these boats cannot navigate the high seas.

[27] "There was little profit from the grain movement. The average chartering price for grain delivered figures out at 2.33 cents a bushel as compared with 2.30 cents a bushel in 1924 and 4.20 cents a bushel in 1923. . . . . In contrast with rates on ore and coal, both of which are free to the vessel, the handling charges on grain assumed by the vessel amount to five-sixths of a cent per bushel, and this deduction from 2.33 cents leaves a narrow margin for the cover of operating expense. . . . . In the way of rates on storage grain, however, the vessels generally were placed at remunerative rates. The average storage was about 5.45 cents a bushel." *Annual Report*, Lake Carriers' Association, 1925, p. 20.

"As nearly as can be ascertained from all available data, the average rate on grain for immediate delivery in 1926 figures out at 3.38 cents per bushel, wheat basis. This is a full cent better than the corresponding rate in 1925. A few pre-season charters were closed on April 6 at 2.75 cents per bushel from Lake Superior to Buffalo, but when navigation opened the rate was 3.5 cents and frequently went to as high as 4 cents per bushel from then on to the beginning of September. . . . . As accurately as can be ascertained, the season's average rate for storage grain to include spring delivery figures out at 5.7 cents per bushel." *Ibid.*, 1926, pp. 120-122.

"It is believed that the rate of 3 cents per bushel from upper lake ports to Georgian Bay and upper Lake Erie ports represents fairly the nominal present rate before congestion begins to assert its influence." *Transportation on the Great Lakes*, Board of Engineers for Rivers and Harbors, U. S. War Department, p. 158.

for an additional charge of $1\frac{1}{2}$ cents per bushel or even less.[28] However, the possibility of operating on the upper Lakes on a 3-cent rate is conditioned by the fact that a very large return tonnage of coal and other bulk cargo is available from Buffalo and Lake Erie ports. For the route from Montreal to Lake Erie ports no adequate return cargo is likely to be available. This, together with the greater delay of navigating the canalized portion of the river, would mean that the probable rate for the total distance would have to be at least 5 cents as a season's average, though it would not rise as sharply as it now does during the rush period from September to the close of navigation.

It must be borne in mind that the export grain movement from our North Central states and the prairie provinces of Canada is extremely seasonal in character. With the opening of navigation in late April or early May, there is a considerable rush to move the hold-over portion of the previous season's crop. By June, this dies down and gives way to a period of stagnation so great that many of the boats of the Great Lakes fleet

[28] "Whether the construction of this channel extension on the same dimensions as already exist above Buffalo, with its same stretches of river and lake navigation, its same lifting and lowering through artificial locks, would result in extending the journey of the lake carrier or in attracting the ocean carrier to the Great Lakes is to them [the farmers] immaterial. . . . . They know that when their grain has been moved 1,000 miles of lake and river navigation to Buffalo for 2 cents per bushel. . . . . that the modern carrier would be glad to add 300 miles of similar transportation to the 1,000 miles already performed and to ask not more than one cent additional to the 2 cents charged for the first thousand miles of service for a cargo already stored on board." Barnes, Julius H., "The Great Lakes Seaway," *American Review of Reviews,* August, 1922, pp. 183-184.

are laid up for some weeks. By August, the new crop from the United States contributes to the revival of the trade, and this is augmented by Canadian grain in September. By the middle of this month. the movement is in full tide and reaches its peak in October. The November movement is less than that of October as it tapers off toward the end of the month, and navigation sometimes actually closes by the last week in November.

Obviously ocean vessels would be at a disadvantage in the early part of the season since they would not be in a position to take on a grain cargo until they had made their way through the St. Lawrence and the Lakes to Port Arthur, Duluth, Chicago, or other port, whereas vessels of the Lake fleet tie up for the winter at these points or at lower lake ports. Hence, they can make a dash down the Lakes with cargo or up the Lakes for cargo the moment navigation opens. In view of the fact that the spring movement is much less in volume than the autumn movement, it would seem that the lake carriers could take care of it so adequately and so much more promptly than ocean carriers as to leave the latter practically no inducement for entering the Lakes for grain cargo prior to the middle of September.

Ocean vessels would also be under a handicap at the close of the season, since they could not operate on the Lakes as late in the year as do the regular lake boats. They must not run any danger of being caught by the close of navigation on the St. Lawrence. Were this to happen, it would result in tying up the boat for a period of six months or more and deprive it of any possibility

of making winter earnings. The lake boats, however, load grain up to the last possible moment and expect to be frozen in at some harbor on the upper or lower Lakes, earning storage charges and in a position to resume movement at the earliest break-up of ice in the spring, some time in advance of the opening of the St. Lawrence River. Frequently the winter storage is more profitable than the summer shipping period, and this feature of the business is responsible for the extremely low rates at which the Great Lakes freighters carry grain during the summer months.[29]

All this means that the peak period of six or at most eight weeks from the latter part of September to about the middle of November would present the only profitable opportunity for ocean vessels to enter the Great Lakes and supplement the capacity of the lake fleet in moving such portion of the crop as it is commercially desirable to move abroad before winter sets in. This is the time of the year when grain rates on the Lakes are at the highest point, thus furnishing the maximum inducement to ocean vessels to enter the Lakes. That it would not, however, exert a very strong pull is evident if we make a comparison between the rate which will probably be charged by the lake carrier and the rate which would have to be charged to make a profitable business for the ocean boat.

[29] Chapter IV has shown that ocean vessels, even tramps, would find it difficult to employ themselves at profitable rates during the winter months as an offset to a grain business carried at low rates during the summer.

It has already been shown that the all-water rate to Montreal runs up to a peak of 12 or 12.5 cents in the busy fall season, or perhaps an average of 11 cents during the period when ocean boats conceivably might engage in this trade. We have estimated also that this rate might be lowered by as much as 4 cents by so improving the St. Lawrence route as to permit the large bulk grain carriers to extend their run down to Montreal. It would therefore be on the average only a 7-cent rate for the Great Lakes run which the ocean boat could count upon. In order to engage in this business, it would have to leave the North Atlantic trade during the busy fall season when grain rates from Montreal to Liverpool run from 12 to 13 cents per bushel. Our previous calculation has shown that an ocean vessel would have to charge for the Lakes run a rate equal at least to 50 per cent of the charge from Montreal to Liverpool, or from 6 to 6.5 cents. Thus, the inducement for the ocean boat to enter the Lakes would be at the most only from one-half cent to one cent per bushel, even assuming that it could secure inbound cargo comparable in quantity and earning power to the west-bound cargo which it would secure if it continued in the North Atlantic trade during these weeks instead of abandoning this for the Great Lakes grain trade.

Hence the most that we could expect is that during the peak season some ocean boats might enter the Lakes on a competitive rate basis established by the Great Lakes carriers. This, as we have shown, would be at a rate approximately 4 cents lower than that now charged

from the head of the Lakes to Montreal. Our conclusion, therefore, must be that the average figure of 8 cents per bushel taken by the Great Lakes-St. Lawrence Tidewater Association as the basis of their computation of freight savings on grain is double the rate which should be used,[30] considering the matter from the standpoint of either the ocean-going vessel or the Great Lakes fleet.

V. INDIRECT BENEFITS TO THE GRAIN GROWERS

In discussions of the relation of the St. Lawrence waterway project to agricultural relief, great emphasis has been laid upon the indirect benefits which will be effected. It is contended, indeed, that these indirect gains will be of very much greater importance than the direct reductions in transportation rates. Accordingly, in this section we will consider the possible effects of reduced transportation rates upon the price of grain which does not move over the waterway. A similar problem is of course involved with all traffic; we single out grain for consideration because it is only in the case of the grain traffic that this argument has been specifically set forth.

As a point of departure for the analysis, it is necessary to quote from the writer who is chiefly responsible for the contention that the annual gains to the farm-

[30] It is interesting to note that Canadian students of the problem have been more modest than proponents of the waterway in this country, claiming only 5 cents per bushel as the saving on wheat. Their argument in support of the five-cent saving seems to be accepted by the Great Lakes–St. Lawrence Tidewater Association, since they have given it widespread distribution in their "Great Lakes-St. Lawrence Ship Channel Facts and Clip Sheet for Editors" of January 7, 1928.

ers of the United States and Canada will run in the neighborhood of a quarter of a billion dollars annually. Mr. A. H. Ritter, in a report prepared for the Great Lakes-St. Lawrence Tidewater Association in 1925, arrives at this conclusion by a method of analysis indicated in the following quotation:[31]

> The real benefit to the farmer will come not from the grain actually exported and shipped over the waterway but from the effect of the lower transportation costs upon all grain produced in territory subject to the influence of the lower rates. . . . . There cannot be separate prices on the same grade of grain for export and for domestic consumption. The latter must be subject to the influence of the former, and the export demand is really the controlling factor in grain prices. . . . The price is not "fixed" in the sense it is controlled, but the price in various parts of the world usually has a definite relationship to the price in the European markets, frequently referred to as the price at Liverpool. Generally speaking the price paid is equivalent to the Liverpool price less the cost of transportation to Liverpool. . . . .
>
> It has been suggested that within twenty years the United States will have no wheat to export. . . . . Even if we have no wheat to export, the price of placing wheat in foreign markets will still have an important bearing upon the general price levels and a generally corresponding effect upon the profit of the farmer. . . . .
>
> Farm prices on grain should be improved as much as 6 cents per bushel as far south as Wichita, Kansas, and nearly as far west as Teton, Montana, while prices in the territory north of Kansas City, Missouri, and east of Frazer, Montana, should be benefited by amounts ranging from 7.2 to 12.1 cents, assuming that full saving would be reflected in the farm price. Possibly this would not be the case, but we are justified in believing that the farm prices would be benefited to an average

[31] Ritter, A. H., *Transportation Economics of the Great Lakes-St. Lawrence Ship Channel,* pp. 216-224.

minimum of 5 cents per bushel throughout the entire tributary area. *This applies on all the grain raised in this territory, regardless of whether the grain enters the channels of trade or is consumed on the farm.* (Italics ours.)

The total grain normally raised in the tributary territory is as follows:

	Bushels
United States:	
Wheat	650,000,000
Oats	1,000,000,000
Rye	60,000,000
Barley	140,000,000
Corn	1,800,000,000
Canada:	
Wheat	300,000,000
Oats	400,000,000
Rye	30,000,000
Barley	70,000,000
Total	4,450,000,000
Less amount actually moving for export and to the eastern seaboard for domestic consumption	525,000,000
Net	3,925,000,000

At 5 cents per bushel the price improvement on 3,925,000,000 bushels would amount to $196,250,000 annually.

The total feasible savings and benefits on grain as a result of the cheaper transportation to be afforded by the Great Lakes-St.Lawrence Ship Channel may be summarized as follows:

Savings in transportation costs on grain moving to the eastern seaboard	$44,000,000
Farm price enhancement on other grain due to influence of cheaper transportation, approximately	196,000,000
	$240,000,000

In a previous section we have shown why Mr. Ritter's estimate of the amount of grain likely to be moved

over the St. Lawrence waterway is seriously in error, and also why his assumed direct freight saving of eight cents a bushel is double the probable actual reduction in freight rates. It follows as a matter of course that the assumed five cents per bushel of indirect gain should be proportionally reduced even in those cases where some indirect benefit may be anticipated. We shall now test the logic of his entire argument with respect to farm price enhancement.

Let us first consider the case of corn. Mr. Ritter applies a price enhancement of five cents a bushel to the entire corn crop of 1,800,000,000 bushels grown in the "tributary area," which gives an annual gain to the farmers of $90,000,000. Corn is apparently included because of the author's general statement that prices of *grain* are made in Liverpool. The truth of the matter is that only about one-half of one per cent of our corn crop is exported, and this mainly to Canada, Mexico, and the West Indies. Accordingly, it is sheer absurdity to suggest that a lowering of freight rates between the Middle West and Europe would affect the whole corn price structure and raise market quotations on the total crop of the corn belt.

Even if the price of corn which the farmers sold were raised, it is difficult to discover just how the corn belt farmer would reap this assumed five cents a bushel gain on the corn which he fed to livestock on his farm. Mr. Ritter does not attempt to enlighten us; but if he assumes that the higher price of corn fed to livestock would proportionately raise the price of hogs and cat-

tle he would be reversing his theory of the price-making process, holding that livestock prices are made by cost of production at home rather than by foreign demand. The truth of the matter is that the price of corn is governed by general conditions of demand and supply, and that any savings that might be effected in freight rates on the 1,000,000 bushels that might utilize the St. Lawrence waterway would have no effect whatsoever upon the remaining 1,799,000,000 bushels. Indeed, the saving on the 1,000,000 bushels exported to Europe via the St. Lawrence would doubtless accrue to the foreign consumer rather than to the American producer, the price of corn being determined in the American market.

The case is practically the same with oats, the second largest item in the list of cereals, for which Mr. Ritter shows gains of $50,000,000. Here again exports via the St. Lawrence would account for a negligible proportion of the total production in the "tributary areas," approximately 12,000,000 out of a total of 1,000,000,000 bushels. A freight saving on the insignificant amount which goes to Europe could have no discernible effect on the domestic price of oats, and it is probable that the foreign consumer would be the chief gainer on that portion that is exported. Moreover, assuming that the domestic price of oats were raised, it is difficult, when one stops to think about it, to see how a book value enhancement of five cents a bushel in the value of the oats which the farmer feeds his work-horses could be realized by the farmer in bankable form.

When we turn to barley, rye, and wheat, we find that the theory of indirect gains has more to commend it.

Barley exports take about 15 per cent of the 140,000,000 bushels produced in the "tributary areas"; and the rye exports amount to 48 per cent of the total. The ratios in Canada are similar though somewhat higher on barley and lower on rye. In the case of wheat, American exports constitute a smaller percentage of the total than in the case of rye, but in Canada the export percentage is much larger. With these cereals the price is clearly determined in world markets, the center of which is Liverpool, and accordingly it cannot be denied that a lowering of the transportation rates to Europe would be to some extent reflected in the price of wheat at the farms. This admission does not, however, carry with it acceptance of Mr. Ritter's extravagant estimates of gains realized, for several reasons.

In the first place, he includes in the "tributary area," as we have shown above, much territory from which wheat would be exported by other routes than the St. Lawrence. Second, he includes the premium wheat which is not exported from the United States and whose price is determined domestically; this amounts to about one-third of the wheat grown in the tributary states. Third, Mr. Ritter does not take into account the fact that the waterway would be open only during the summer season and that hence such savings as are effected would apply to only that portion of the crop which was sold during the season of open navigation. Fourth, Mr. Ritter applies his savings on wheat, rye, and barley, as with the other cereals, to the entire domestic crop, whether sold in the market or consumed on the farm.

One may properly inquire just how the farmer is to pocket the enhanced price of wheat on such portion of his crop as is used for chicken feed and as seed for the next year's crop. Will the price of eggs, both those which the farmer consumes and those which he sells, be proportionately increased; and will the farmer's wheat the following year be higher priced because of the increased cost of seed wheat—or will the price of next year's crop, perchance, still be determined at Liverpool? It is of interest to note, in this connection, that for some reason not altogether clear Mr. Ritter failed to pyramid his estimate of gains to the livestock farmer in a similar manner so as to apply it to the entire production of livestock products.

Mr. Ritter has proceeded on the general assumption that the price of grain throughout the tributary territory would be enhanced, on the ground "that there cannot be separate prices on the same grade of grain for export and for domestic consumption." Admitting the fundamental law of economics that we cannot have two prices in the same market at the same time, it must be remembered that the "tributary territory" is surrounded only by an imaginary line and is not a watertight compartment set off from the rest of our price structure. Even supposing that farmers adjacent to lake ports received indirect benefit equal to the whole of the four cent freight rate saving, this must taper down to zero at the edge of the territory where the Great Lakes grain market area merges into Gulf or Pacific export areas, whose prices are established on a basis of

transportation costs which would be unchanged by the opening of the St. Lawrence waterway. If we assume then a series of concentric circles of indirect benefit ranging from four cents to zero, the average would be but two cents.

Mr. Ritter has, however, admitted that the price enhancement would perhaps nowhere amount to the whole of the freight rate saving (see quotation above)—some of the benefits apparently going to middlemen or to foreign consumers. The situation in this regard is, however, different in the United States and Canada, respectively. In the former, competition is much less keenly adjusted to the price basis of the export market, and we believe that less than 50 per cent of the indirect benefits would, on the average, go to the American producer. In Canada, on the other hand, the export market exerts a highly dominating influence and the grain-producing territory is much more completely focused upon the North Atlantic outlet to European markets. In the case of Canadian wheat, therefore, the saving from the reduction of freight rates would more largely accrue to the farmer; but even here competition from other producing areas would tend to depress the price in foreign markets, and thus enable the ultimate consumer to share in the gains. In view of the ready expansibility of Canadian wheat production, moreover, it would seem that over a period of years the initial benefits realized by the Canadian farmer would tend to disappear.

It should also be pointed out that the indirect gains to the farmers in the producing regions which would be benefited by the St. Lawrence route would to some extent be at the expense of other groups in Canada and the United States respectively. The wheat producers outside the tributary areas would find their prices adversely affected by the new competitive conditions. Moreover, any enhancement in the domestic price of grain would mean that Canadian and American consumers in the territory thus affected would have to pay somewhat more for grain products.

The conclusion at which we arrive from the analysis in this section is not that the grain farmers of the interior Northwest would receive no benefit if the St. Lawrence waterway reduced freight rates. When account is taken of all factors, it is clear, however, that the gains to the farmer would be only the merest fraction of the amount usually claimed, and that such gains would in no small part be at the expense of other groups, including the farmers of the rest of the country. We shall not attempt, at this place, to compute any figure of estimated indirect gains to the grain farmer. The estimate of potential grain traffic which we have derived in this chapter will be added to the potential volume of other traffic, and in later chapters we shall consider the relationship of the savings thus effected to the total cost of the waterway.

CHAPTER VIII

THE WATERWAY AND TRAFFIC CONGESTION

The revival of interest in a deep waterway between the Lakes and the seas dates, as we have seen, from the period of severe traffic congestion on the railroads during and immediately following the World War. It was urged that the inadequacy of the railroad service had been abundantly demonstrated and that railroad development in the future could not be expected to keep pace with the growth of population and traffic requirements. (See Chapter I.) To add railroad equipment without increasing line and terminal facilities, it was said, would merely contribute to greater congestion, while to build the additional lines and terminals regarded as necessary would involve the expenditure of something like eighteen billions of dollars.[1] The present chapter will be devoted to three major issues: (1) the ability of the railroads to handle satisfactorily the transportation requirements of the country; (2) the adequacy of the waterway as an agency for relieving traffic congestion; and (3) the relative traffic capacity of the waterway compared with that of an all-freight railroad.

[1] See MacElwee, R. S., and Ritter, A. H., *Economic Aspects of the Great Lakes-St. Lawrence Ship Channel*, 1921, pp. 16 and 31.

I. RAILROAD TRANSPORTATION CONDITIONS

A. In the United States

In the two decades prior to the Great War railroad service was not altogether satisfactory. Owing to a combination of circumstances which need not here be discussed, railroad facilities in the later years before the war were becoming increasingly inadequate.[2] There was a shortage of cars in nearly every seasonal period of heavy traffic, and in years of exceptionally active business railway congestion was a matter of serious concern. It was not, however, until the war that the condition of railway service became a matter of vital concern.

Conditions during and for a time after the war were quite abnormal. Railroad service from the latter part of 1916 to practically the close of the war, again in the latter part of 1919, during much of 1920, and in 1922, was extremely bad. There was, however, a tendency to exaggerate the losses suffered by shippers in the early postwar period[3] and to hold the railroads accountable for conditions beyond their control. The later war years and the years 1919 and 1920 were in every sense extraordinary. Traffic jumped from 277 billion ton-miles in 1915 to 408 billions in 1918, a 50 per cent increase in three years; and it was necessary that much

[2] See, for example, Hines, Walker D., *War History of American Railways*, 1928, Chapter 1.

[3] Compare MacElwee and Ritter, *ibid.*, p. 16, who estimated this loss at 100 million dollars per day. At this rate the annual loss would have been over 36 billions or approximately one-half of the annual income of the people of the United States in 1920.

of this traffic be singled out for movement with the greatest possible expediency. There was also a marked concentration of traffic on the North Atlantic seaboard, where storage and transfer facilities were inadequate and ships were lacking to move out promptly such of the traffic as was destined for immediate overseas delivery. Special conditions of this character obviously were the immediate cause of the congestion which occurred during the war period.

Some of these conditions continued for a year or more after the close of hostilities, and other developments were also contributing factors. Exports were very heavy; trade was in a state of feverish activity, the total traffic in 1920 exceeding that of 1918. The coal strike aggravated conditions. Moreover, there was a general state of indecision during the period prior to the return of the railroads from government to private operation on March 1, 1920, which militated against effective railway operation.

The last year of poor service was 1922,[4] when large car shortages occurred despite the rather moderate volume of traffic moved. By this time the unusual export situation and the lack of ships had passed from the picture as important factors contributing to poor railroad service. The difficulties attending a period of transition from government to private operation, however, had not yet wholly disappeared. The shopmen's strike and unusually severe weather conditions were other special factors in this year's situation.

[4] Car shortages and congestion were escaped in 1921 only because traffic was very light in that year.

Since 1924 railroad service has been exceptionally good. In contrast to the recurrent car shortages in seasons of heavy traffic before the war and the condition of chronic congestion during the period 1916-1922, the railway service during the past five years has been remarkably satisfactory. Cars have not only been available as wanted, but shipments have moved with a promptness, regularity, and dependability never before

CAR SUPPLY IN WEEK OF PEAK TRAFFIC, 1918–1928

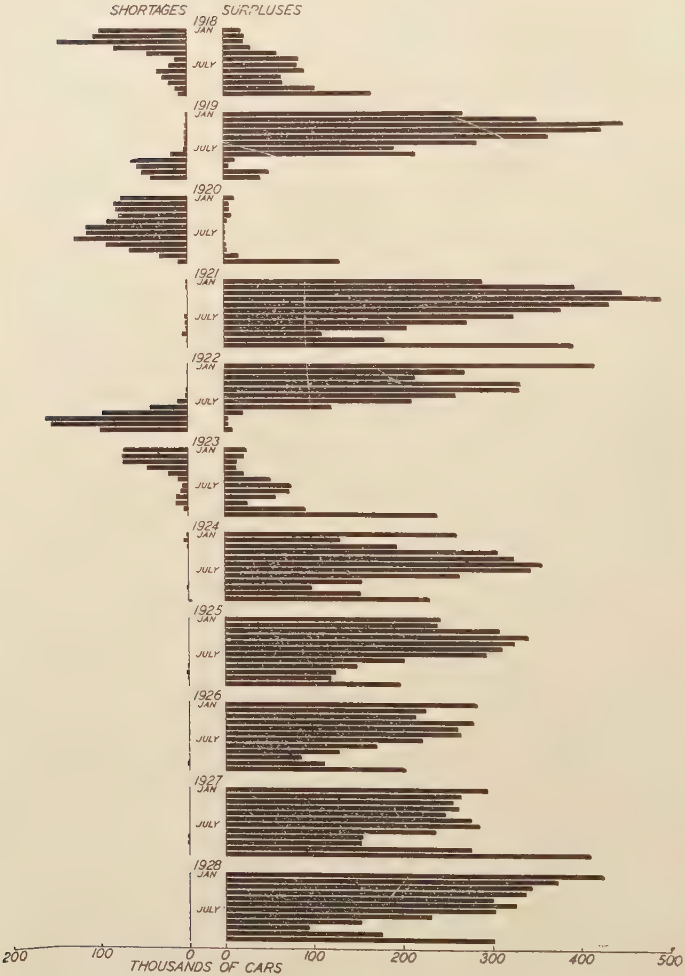
Year	Cars Loaded	Serviceable Surplus Cars	Reported Car Shortage
1918	991,980	66,988	21,248
1919	995,901	7,411	65,611
1920	1,018,539	2,188	69,517
1921	964,811	99,971	6,795
1922	999,718	3,716	179,239
1923	1,097,493	41,745	15,331
1924	1,102,336	99,952	1,151
1925	1,124,438	162,397	636
1926	1,208,878	81,011	1,945
1927	1,129,055	151,893	2,151
1928	1,196,768	103,906	279

enjoyed. So revolutionary, in fact, has been the improvement that production and distribution practices have adapted themselves to what appears to be a new day in transportation. The car surpluses and shortages for each month from 1918 to 1928 inclusive are shown in the chart on the following page. The crucial test is the condition of car supply in the weeks of heaviest loading. The table on this page shows the remarkable change that has occurred.

Contemporaneous with an increase of traffic from 1922 to 1928, there has been a decline of car shortages

CAR SURPLUSES AND SHORTAGES

By months, 1918-1928



to a wholly negligible figure. Shippers for the last four or five years have been receiving practically 100 per cent compliance with their needs for cars, while service has also been expeditious and in all other important respects extremely satisfactory.[5]

Improvements in railroad service have been effected chiefly by better utilization of existing facilities. After the return of their properties on March 1, 1920, the railroads were faced with both widespread public criticism of their service and serious financial difficulties. In 1923, therefore, they made a resolute and concerted effort to improve their service and at the same time to reduce their costs. They adopted standards of good practice in car loading, in car movement, and in equipment repair. The car service rules, governing the movement or return of equipment between lines, were greatly improved, and effective provision was made for their enforcement.

Perhaps most striking, from the public point of view, the railroads organized regional advisory boards, whose purposes were to make known to the railroads in advance what the shippers' car requirements were to be and to provide a regular channel for the handling of complaints against the service furnished by the railroads. It has been through these means—better management of the individual property, coöperation between carriers, and coöperation between shippers and carriers—rather than through additions to equipment or

[5] The Secretary of Commerce in his annual report released in November, 1928, states that the time of shipments in transit has been reduced at least one-third under that at the close of the war.

other facilities that the remarkable improvement in service since 1922 has been effected. In fact, additions to equipment since 1922 have been very light. In 1925 there were about 3 per cent more cars than in 1922; but since then there has been an actual decline in number of cars owned to a figure below the 1921 number, though, owing to the increase in average size, a slightly greater aggregate of capacity is now available.

The railways at present have a substantial reserve of carrying capacity. The fact that in recent years the largest volume of traffic ever known has been carried over our railroads without sign of congestion or objectionable delay, even during the peak of traffic, indicates beyond doubt that present line and terminal facilities are entirely adequate to present needs. Present railroad facilities are, in fact, not only adequate to take care of normal traffic requirements, but there is also a substantial reserve capacity. That is to say, the present supply of railway line and terminal facilities could handle, with reasonable satisfaction, a volume of traffic considerably greater than that which has been carried in recent years.

It has been estimated that one-half of the nation's traffic is concentrated on about 25,000 miles of line, or one-tenth of the total route mileage of the country.[6] It is the view of Mr. Loree that on this heavily used tenth of the mileage there is a reserve of at least 25 per cent, and that on the remaining nine-tenths of the mileage the reserve at the present time is very much greater than

[6] Loree, L. F., *Railroad Freight Transportation*, 1922, p. xiv.

this.[7] Such a reserve capacity is of course highly desirable from the point of view of shipping interests; it enables the roads to meet the needs of occasional periods of extraordinary traffic movement, and it insures that for some years to come the normal growth of traffic will not produce a condition of acute congestion. It does not, however, imply that it is unnecessary to add continuously to railroad facilities in anticipation of further increases of traffic.

The prospect for a continuance of comparatively high standards of railroad service appears to be reasonably good. The adequacy of railroad facilities a decade or so hence will, of course, depend upon the rate of traffic growth in comparison with the rate of increase of railroad carrying capacity. The growth of railway freight traffic over a period of years, in ton miles, is shown below:

1895.....	85,000,000,000	1924.....	392,000,000,000
1914.....	288,000,000,000	1925.....	417,000,000,000
1920.....	413,000,000,000	1926.....	447,000,000,000
1923.....	416,000,000,000	1927.....	432,000,000,000
		1928.....	436,000,000,000

From 1895 to 1914, the number of ton miles of traffic increased at the rate of 6.62 per cent a year. From 1914 to 1920 the annual increase was at the rate of 5.69 per cent; from 1923 to 1928, an era of industrial prosperity, the increase was, however, at the rate of only about 1 per cent a year. The causes of this lessened rate of growth in recent years are in part of a relatively permanent character, such as the slower rate of popula-

[7] *Railway Age,* January 3, 1925, Vol. 79, p. 9.

tion growth; but they are in part also the result of certain temporary factors, among which may be mentioned the loss of trans-continental traffic to intercoastal vessels utilizing the Panama Canal, and the rapid rise during this period of motor truck competition. While the railways will, of course, have to share future traffic with these competitors, there will not henceforth be such heavy outright losses of existing traffic as was the case in the first period of this competition. It is, therefore, reasonable to assume that the rate of traffic increase in the next decade or so will be somewhat greater than it has been in the past five years.

If we compare the last pre-war year, 1914, with the year 1928, we find that the average annual increase of traffic on the railroads of the country as a whole was approximately 2.91 per cent.[8] If the rate of increase is maintained at 2 per cent, the total volume of traffic to be carried in 1940 would be approximately 550,000,000,000 ton miles.

A total of 550,000,000,000 ton miles of traffic could, in fact, be handled by existing railroads if their present carrying capacity were completely utilized. If, however, we are to maintain a reserve capacity substantially equal to that which we now have, it will be necessary to increase railroad line and terminal facilities at the rate of approximately 2 per cent a year. This would require an annual expenditure for such facilities, for the country as a whole, amounting to something like $500,000,000.

[8] The situation on the roads in the territory with which the St. Lawrence waterway would compete does not vary greatly from that in other parts of the country as a whole.

Whether railroad facilities will be expanded at such a rate will depend primarily on financial considerations.

There are no serious physical obstacles to the expansion of railway facilities between the Middle West and the Atlantic seaboard. It may be noted first that large additions to capacity are possible without appreciable increase of trackage. Electrification, improved signaling, and the wider adoption of such effective practices as longer locomotive runs, "main tracker" trains, etc., will work substantial increases in present capacity, and with only minor additions to line or terminal facilities. Consolidations, now under active consideration, also promise to link up certain lines in the Chicago-New York area for more effective use, and to work some diversion of traffic from the more heavily used lines to those which have been less extensively used in the past.

As for new line facilities, the need will be in part for additional main tracks, sidings, and so forth, and in part for entirely new construction. While the good passes through the Allegheny Range have long been exploited and railroads skirting the foothills of mountain ranges may find it difficult in places to lay additional lines, there are no downright physical obstacles to the expansion of facilities. In fact, at least one entirely new line between Chicago and the Eastern seaboard has already been proposed.

At our Atlantic terminals, also, there is either excessive capacity today—as at Boston and Baltimore, and the Virginia and Carolinian ports, many of which are crying for traffic—or ample room for expansion. The

New York-New Jersey harbor district has vast areas of unused lands which it can develop when the need arises. The lighterage system in use there makes for greater flexibility of harbor operations, the value of which is manifest. Some of our interior terminals, particularly Pittsburgh, do not, however, present so favorable a picture. Here physical obstacles seem very serious; in fact plans are now being considered by the railroads to provide means of going around this terminal with through traffic. In general, however, we can say that the obstacles to future railroad expansion in the Eastern section of the country are not physical in character.

The financial situation confronting the railroads following the war was a serious one. During the last few years, however, the general credit of the roads has improved greatly, in part because of increased operating efficiency and the expansion of earnings, and in part because of the easier condition of the money market, particularly in the years 1924 to 1927. The conditions which will prevail over the next decade cannot now be gauged. They will depend in no small degree upon factors outside the control of the railroads, and at present unpredictable—such as the attitude of the public, as expressed through legislation, the trend of interest rates and the general condition of the money market. All that can now be said is that, in the absence of adverse financial factors during the next dozen years, the roads should be able to expand materially their carrying capacity, in keeping with requirements of efficient and

economical operation. The worst that can reasonably be anticipated is a lessening of the present reserve capacity.

B. In Canada

The problem of traffic congestion in Canada requires no extended discussion. The basic fact is that Canada is greatly over-supplied with railroad facilities; "there is not enough traffic to enable all the railway lines to pay their way."[9] The Canadian railroads carried in 1926 only 846,388 tons per mile of line, a figure only slightly above that for 1914 (716,359), and less than half of the corresponding figure for the United States. So far as the year-around traffic needs are concerned, the St. Lawrence waterway is, therefore, not now needed as a relief agency and will not be needed as a relief agency ten or fifteen years hence. Canadian population, it may be noted, has not been increasing in recent years.

Canada is, however, predominantly an agricultural country and as such has a heavy seasonal peak of traffic, primarily in grain. A large part of the Canadian grain movement is carried to the lower lakes on lake boats and a considerable part of it moves to Montreal via the old Welland and the 14-foot canals through the St. Lawrence. Since, however, the capacity of the present Welland and St. Lawrence is not adequate to take care of the full demand for grain shipments from the latter part of September to November, exporters arrange for shipments down the Lakes to Georgian Bay ports, whence

[9] Jackman, W. T., *Economics of Transportation,* 1926, p. 704.

the grain is conveyed to Montreal by rail. Grain continues to move east by rail after the close of navigation; but considerable quantities are stored either in elevators or in boats at the foot of the lakes, at Georgian Bay ports, or in the west.

Is a waterway deep enough to accommodate ocean vessels essential for the movement of Canadian grain traffic? If it is desirable to eliminate the railroads altogether from the carrying of the grain traffic during the autumn season and to carry the entire load by water, this can be done, as we have shown in the preceding chapter, more economically in lake than in ocean vessels. Similarly, if it is important to move a larger portion of the total Canadian grain crop east to seaboard ports before the closing of navigation, a better alternative than a waterway for ocean ships is to deepen the St. Lawrence sufficiently to permit lake boats drawing 19 or 20 feet to pass down to Montreal.

It is, however, by no means clear that any great economic significance attaches to a quicker movement of the Canadian grain crop to tidewater. In recent years, as much as 70 per cent of the Canadian grain is moved east from Fort William and Port Arthur during the period of open navigation.[10] An acceleration of the marketing process by means of more adequate shipping facilities during the late autumn would work at cross purposes with the efforts of farm groups who, by means of grain pools and better credit facilities, are hoping to

[10] Booth, J. E., "Cooperative Marketing of Grain in Western Canada," U. S. Department of Agriculture, *Technical Bulletin* No. 63, 1928.

market their grain in a less precipitate and more "orderly" fashion.

It should also be noted that the diversion of such of the grain traffic as is now carried by rail in the late autumn is not without adverse effect upon the revenues of the Canadian railroads. This phase of the problem is discussed in the following chapter.

II. THE ST. LAWRENCE AS AN AGENCY FOR TRAFFIC RELIEF

The analysis of the previous section has led to the conclusion that no serious or chronic state of traffic congestion is likely to develop within the next ten or fifteen years. In order to make our analysis complete, however, we shall now assume that seasonal traffic congestion does develop, and inquire whether the St. Lawrence waterway has peculiar attributes which recommend it as an agency for relieving such congestion.

The St. Lawrence waterway has one vital defect from the point of view of relieving seasonal congestion. The principal peak of traffic occurs in the autumn months, typically October, November, and December, sometimes beginning a little earlier and sometimes extending beyond the holiday season. Since the waterway would not be open for navigation for ocean vessels later than the middle of November, it is clear that it could not adequately take care of peak seasonal requirements. A minor traffic peak also occurs in March, before the opening of navigation in the spring. Thus, at best, the waterway could handle the normal peak load for only a portion of

the peak load season, and hence about the same amount of additional railroad facilities would be needed in any case.

Not only would the waterway not adequately relieve traffic congestion on through hauls between the Middle West and the Atlantic seaboard, but it would still be necessary to provide the additional rail facilities required in originating and delivering the greater part of the traffic which might move over the water route. Moreover, the waterway would not provide relief for that vast total of traffic which moves elsewhere than between lake ports and the Atlantic seaboard.

III. A COMPARISON OF THE TRAFFIC CAPACITY OF THE ST. LAWRENCE AND A FREIGHT RAILWAY

We have seen that the St. Lawrence waterway is not well adapted to serve as an agency for relieving possible traffic congestion between the Middle West and the Atlantic seaboard. Approaching the problem from another angle, we will now inquire whether there are other more effective and economical means of relieving any traffic congestion that might possibly develop in the future. We shall direct our attention to the possibilities of an all-freight railway constructed without reference to the needs of passenger traffic, and intended especially to carry between the interior and the Atlantic coast the types of traffic which the St. Lawrence is expected to handle. It will be necessary first to consider whether the carrying capacity of such a freight railroad would compare favorably with that of the St. Lawrence waterway.

(a) *Traffic capacity of the St. Lawrence.* The determining factor in the capacity of the St. Lawrence waterway is the rate of movement through the locks. We can ascertain the theoretical maximum possibilities by estimating the number of tons that can pass through a given lock in the course of a year. The starting point for the estimate is the average amount of time that it takes a boat of maximum capacity to move through a given lock.

As has already been shown,[11] it would require roughly an hour for each lockage. We shall take as the average boat load the very high figure of 9,000 tons of freight. The number of tons of freight that can be carried by a vessel is considerably greater than either the gross or the net tonnage figures, which are units of vessel measurement. With heavy commodities such as grain, which can be compactly stored, a vessel of 4,000 gross tons can carry roughly 6,000 tons of freight. Thus the average carrying capacity of all vessels engaged in regular services out of Montreal is roughly 5,400 tons of heavy freight, and of all those engaged in the cargo carrying trade of the United States a little less than 6,000 tons of heavy cargo.[12] Of the boats constructed in world ship yards since 1919, having a draft between 23′ 6″ and 24′ 6″, the average carrying capacity is approximately 7,500 tons of cargo. There are about a score which have a capacity around 9,000 tons of heavy compact

[11] See p. 68.

[12] For gross tonnage figures, United States and Canadian cargo vessels respectively, see Chapter III.

freight. If we take 9,000 tons as the carrying capacity of the boats that would utilize the St. Lawrence, we will be assuming that all of the boats that traverse the canal will be of practically the maximum size that could pass through it and that all of them are carrying the kind of freight which permits the maximum tonnage.

We may now compute the theoretical maximum capacity of the St. Lawrence waterway as follows:

9,000 tons = capacity of a lock per hour
$9{,}000 \times 24 = 216{,}000$ tons per day
$216{,}000 \times 195$[13] $= 42{,}000{,}000$ tons a year

This estimate of the theoretical maximum capacity of the St. Lawrence waterway is, it will be seen, based upon the assumption that there is a steady stream of large boats loaded to maximum capacity with heavy compact freight and passing through the locks every hour day and night[14] for the 195 days that the canal would be open.

These estimates assume that the canal will have a chain of single locks, as the present project calls for. It is stated by the United States St. Lawrence Commission, however, that "the capacity can be increased to any reasonable extent that may be desired by the construction of additional locks paralleling those first installed." The Joint Board of Engineers in its 1927 report says that the capacity of a 25-foot waterway would be 16,000,000 tons per annum with a chain of single locks, and that this could be increased to 24,000,000 tons by

[13] See page 62 for season of navigation.
[14] There is some doubt about the feasibility of night traffic in the restricted channels.

the installation of duplicate locks.[15] (Paragraph 114.) Assuming this ratio of increase of capacity with the duplication of locks to apply equally to the 27-foot project, a waterway with a system of double locks would have a theoretical maximum carrying capacity of approximately 63,000,000 tons a year.

No figures are available to indicate the additional cost that would be involved in making the water route a double line traffic route. We say " double line traffic route " because if traffic is to move in a double stream through the locks it must also move in a double stream in the reaches approaching the locks, and also in other restricted portions of the route. Wide stretches here and there on the route would merely make it possible for the faster boats to pass the slower ones, and in our estimates of boat capacity we assumed that all the boats would be of the largest and fastest type that could navigate the route. It would thus appear that very considerable additional costs would be involved in making the St. Lawrence a double line traffic route. No attempt, however, will be made here to estimate the additional costs involved. It is sufficient for our present purpose to note that the existing single lock project, which would cost about $712,000,000, has a theoretical carrying capacity of something like 42,000,000 tons a year.

This theoretical maximum capacity is, however, very different from a practical realizable capacity. Traffic

[15] The United States St. Lawrence Commission in its *Report* made in 1926, stated that: " After making full allowance for the seasonal variation in the volume of traffic to be handled, the capacity of a waterway of this depth (27 feet) with a chain of single locks, is estimated at 30,000,000 tons per annum."

never originates as a steady stream, evenly distributed hour by hour, day and night, week after week, and month after month. Our traffic analyses have indicated a highly irregular flow for given items of traffic, wide seasonal fluctuations in the total volume, and a lack of balance as between inbound and outbound traffic. (See page 110.) Practically all of the grain movement, for example, would have to occur in a short seasonal period, and in the main in boats that would pass through the locks inbound without cargo. The route must, moreover, accommodate boats of all types and sizes, not merely the largest possible boat loaded to capacity with compact heavy cargo. Thus the actual realizable capacity is but a fraction of the theoretical capacity.[16]

(b) *The capacity of a freight railway.* In taking up the question of railway capacity we must inquire, first, how far $712,000,000, the estimated cost of providing the St. Lawrence route, would go in providing additional railroad facilities. For purposes of comparison, we may take as an alternative to the St. Lawrence waterway an all-freight railroad between, say, Chicago and Boston.

[16] The existing 14-foot Welland canal had a traffic in 1927 amounting to 7,272,000 tons, of which 5,043,000 was grain and most of the remainder pulp wood, coal, and sand. This represents virtually the maximum capacity. The smaller route has some compensating advantages in the way of faster movement through the locks and in the considerably longer season.

The movement of traffic through the Soo in 1927 amounted to 83,354,064 tons. This was made possible by a triple set of locks and by the fact that the largest grain boats carry in excess of 15,000 tons and the specially constructed ore boats 18,000 tons. The season for this route, for reasons discussed in Chapter IV, is also considerably longer than the season for the ocean commerce.

The average investment per mile of Class 1 railroads in the Eastern District amounted in 1927 to $121,900, including equipment. The cost of reproduction would, however, doubtless be considerably more than this at the present time. If we take $250,000 per mile for line and terminal facilities and equipment, we will, therefore, be making a liberal estimate. The length of the route from Chicago to Boston is about 1,033 miles, which would make the cost of the railroad approximately $260,000,000. Three double track all-freight railroads between the Middle West and the Atlantic seaboard could, therefore, be constructed and equipped for the cost of the St. Lawrence waterway.

The interest charges on the capital investment in the railroad, figured on the same basis as with the waterway, namely at 4 per cent, would be approximately $10,400,000. The ratio of the cost of maintaining way and structures to the overhead charges on Class I roads is about 55 per cent, which would make the total of these charges $16,000,000 annually. Since this road would presumably have an exceptional volume of traffic, we will have to assume that the cost of maintaining the way and structures would be greater than normal, and we shall therefore raise the figures to $20,000,000. This may be compared with similar overhead charges on the waterway of approximately $40,000,000. We may now compare the carrying capacity of this freight railroad with that of the St. Lawrence water route.

The theoretical maximum capacity of the railroad will depend upon the size of the train load, speed, and the

distance that must separate the trains. We may assume a block signal system that would permit trains to run a mile and a half apart. Inasmuch as we shall have a double track freight railroad, with all trains on a given track running in the same direction, we may assume a speed of 20 miles an hour for through trains.[17] This would enable the movement of 12 trains per hour. We shall assume the average freight train to consist of 50 cars of 40 tons each, or 2,000 tons per train. That this figure is not excessive as a theoretical maximum is evident from the fact that the Virginian Railway, a coal road between West Virginia and the Virginia coast, carried in 1927 an average of 2,323 tons per train. We may now compute the theoretical maximum capacity of a freight railroad as follows:

12 trains = number per hour
12 × 2,000 = 24,000 tons per hour
24,000 tons × 24 = 576,000 tons per day
576,000 × 365 = 210,000,000 tons per year
210,000,000 × 2 = 420,000,000 tons per year both ways

The theoretical maximum capacity of an all-freight double track railroad is thus approximately 10 times that of the St. Lawrence waterway—420,000,000 as against 42,000,000. The three railroads that could be constructed for the cost of the waterway would have a combined capacity approximately 30 times that of the water route.

Such figures for the theoretical maximum capacity of a railroad are, however, as far from actually realiz-

[17] The actual average speed of freight trains moving under all conditions, and including locals, in the Eastern District is 12.8 miles per hour.

able possibilities as are the theoretical maximum figures that are usually given for a waterway. Railroad traffic does not originate in a steady stream, nor is it evenly balanced as between outbound and inbound movement; hence there would be many empties. The route would have to take care of local as well as through traffic, and the size of the trainload would have to be adjusted to meet the needs of varied types of traffic.

For purposes of comparison we may indicate the volume of traffic that has been carried by existing railroads under favorable conditions. The Pennsylvania Railroad has in a single day sent as many as 15,000 freight cars through the city of Altoona—a 50-car train every five minutes. The average number of tons per car is not definitely known, but for the Pennsplvania System as a whole it is 30 and was presumably greater on this main line. The number of tons moved in a day was thus in the neighborhod of 500,000—a figure which may be compared with the theoretical maximum assumed for our route of 576,000 tons per day. This traffic was moved on two tracks—two other tracks accommodating 40 passenger trains the same day.[18] The New York Central from Albany to New York City on two tracks moves 175 [19] trains a day (passenger and freight) which is at the rate of one train every eight minutes. The average number of cars per freight train on the New York Central is 50; and if all these trains had been freight

[18] Statement of Mr. Fisher, General Superintendent of Transportation, before Great Lakes Regional Advisory Board, February 11, 1926; *Proceedings*, p. 38.

[19] *The Railway Age*, March 2, 1929, p. 517.

trains the daily movement would have been approximately 9,000 cars. The Pittsburgh & Lake Erie, which derives one-ninth of its total revenue from passenger train operation, carried 38,800,000 tons of traffic in 1927. This road has 231 miles of line, of which 54 miles are quadruple track and 117 miles double track. Since not all of this traffic was through traffic, it did not represent the total that moved past a given point.

In the estimated cost of the St. Lawrence waterway, no provision was made for ships, whereas the railway figures given above include rolling stock and equipment. Any compensating economies which the waterway might have would therefore be measured by the extent to which the cost of actually moving traffic by rail might exceed the cost involved in constructing and operating boats. The truth of the matter is that the direct cost of moving traffic a given distance over a railroad is only a little greater than the cost of moving the same traffic over an inland waterway. This is not, however, the place to enter into any detailed analysis of relative operating costs. It suffices for our present purpose to have shown that, in the matter of fixed charges, which bulk so large in transportation costs both by rail and by water, the advantage of the railroad is of overwhelming importance.

From the analysis in this chapter, we arrive at three conclusions: first, that in the normal course of development there is not likely to be any serious traffic congestion during the next decade or so; second, that the

St. Lawrence waterway is not well adapted for the relief of traffic congestion; and, third, that in any event possible traffic congestion could be much more economically relieved by means of the construction of a double track railroad than by the construction of the St. Lawrence waterway.

CHAPTER IX

RELATION TO RAILWAY RATE CONTROL

Much of the interest in the St. Lawrence waterway comes from the belief that it would serve as an effective means of controlling the rates charged by existing transportation agencies. To achieve such control, it is not thought to be necessary that the proposed route carry any considerable volume of traffic, or indeed any traffic at all; the mere presence of the waterway is held sufficient to bring about a reduction of rates between the interior of the continent and the seaboard. Thus Mr. Ritter, speaking for the Great Lakes-St. Lawrence Tidewater Association, defines traffic "available for the waterway" as that which would be "subject to the favorable influence of the waterway, including the portion which will move during the season when navigation is closed."[1]

It is clearly necessary to give careful consideration to the relation of the proposed waterway to the problem of railway rate control. If there is serious need for reducing existing transportation rates from the Middle West to the seaboard, it is important to determine how effective the waterway would be as an agency of rate control as compared with other possible means of control. We must also consider the relationship of the

[1] *Transportation Economics of the Great Lakes-St. Lawrence Ship Channel*, p. 124.

waterway to the problem of maintaining the railroads in a sufficiently sound financial condition to enable them to continue to furnish the service which we require of them. There is involved here a problem in national planning that is of the greatest significance to the people of the country as a whole. We shall consider the issues involved first from the point of view of the United States, and second from the standpoint of Canada.

A. IN THE UNITED STATES

As was indicated in the opening chapter, the Middle West feels that it labors under a severe handicap because of the distance which separates it from the seaboard. While this disadvantage has been a matter of more or less perpetual concern, the feeling has been greatly intensified as a result of the opening of the Panama Canal, which has served to increase the relative advantages of both seaboards and in effect to increase the distance from the Middle West to tidewater.[2]

The general transportation difficulties under which the Middle West labors have been greatly exaggerated in recent discussions. The largest single item of traffic moving to the seaboard from the Middle West is grain, and the bulk of the grain traffic, as we have shown in Chapter VII, has for generations enjoyed the advantages of relatively low combination lake and rail rates. While these rates, like nearly everything else, are somewhat higher than before the war, higher transportation charges cannot be assigned as an important factor con-

[2] For a precise statement of the facts, see p. 8 above.

tributing to the post-war agricultural depression. Nor has the opening of the Panama Canal[3] hurt the farmers of the Middle West. All this is of course not to deny that it would be distinctly advantageous to the Middle Western grain grower if a St. Lawrence deep waterway effected reductions in transportation costs, and he obviously has the right to hope and work for lower rates than now prevail.

Nor has the opening of the Panama Canal adversely affected the position of the Middle Western manufacturer with reference to the export trade to Europe. The situation here is merely that the Atlantic Coast has always enjoyed a distance advantage in trade with Europe. While the Middle West would naturally like to see this distance differential reduced to the minimum, there is no ground for complaint that it is suffering from some artificial disadvantage.

The Panama Canal has had an important direct effect upon the Middle West only in connection with trade with the Pacific Coast, and to some extent the west coast of South America and the Orient. The Atlantic and Gulf Coasts have, in effect, been moved relatively nearer to the Pacific.[4] How seriously this reduction in the cost of transportation between the

[3] The Panama Canal has favorably affected the farmers of the grain producing region of the Pacific Northwest, including part of Montana, by giving them a somewhat lower rate to Europe.

[4] The Panama Canal has, of course, reduced the cost of moving goods from the Pacific Coast to the East; but, since the Far West is not an important manufacturing region, the adverse effect upon the Middle West could not be significant. It has also given to the East coast and points as far inland as Pittsburgh the advantage of low lumber and petroleum rates.

coastal regions has affected the Middle West could only be ascertained by a study of the relative rates on many different manufactured commodities. In some cases it has in fact taken markets away from the Middle West, and in other cases it has not. But, in any event, it is clear from our traffic analysis that no considerable volume of traffic would pass out over the St. Lawrence en route for the Pacific Coast if the canal were constructed; and it follows that the opening of the St. Lawrence waterway would not restore the equilibrium in transportation rates between the East and the Middle West, and the West Coast which formerly prevailed.

A more effective means of restoring this equilibrium would be through controlling intercoastal water rates, which have been so low since the war that they have not been profitable to ship operators. In fact, as the present surplus of war-built ocean shipping diminishes, these rates may be expected to rise of their own accord.

By and large, the Middle Western manufacturer, with low domestic lake rates on coal, iron ore, and other raw materials, and with an enormously rich interior market for his products, is not suffering severely from new and artificial transportation conditions. While the opening of the Panama Canal has adversely affected the competitive position of the Middle Western manufacturer in certain markets, it has given rise to no critical condition that warrants the granting of a subsidy for relief purposes.

If the opening of the St. Lawrence waterway resulted in a reduction in general transportation rates between

the Middle West and the Atlantic seaboard, it would obviously be an advantage to the Middle West in connection with its export traffic. It would also be an advantage to the Middle Western manufacturer in connection with the importation of certain materials. But, on the other hand, it may be noted that it might lessen the cost of laying down in Middle Western markets goods produced in foreign countries and also in the Eastern states, and thus increase the competition of the Middle Western manufacturer in his own natural market. The obvious reason for the interest of the New England manufacturers in the St. Lawrence is that they hope that it may enable them to enlarge their sales in the Middle West. It may also be added that insofar as the waterway reduced import rates to the Middle West it would lessen the effectiveness of existing protective tariff duties.

I. The Waterway as a Regulator of Rail Rates

Assuming, however, that it is desirable to lower transportation costs between the Middle West and the seaboard, we must still inquire whether the waterway offers the best means of accomplishing the desired end. We believe that it is not the most desirable means, for two reasons: first, because of the costs involved, and, second, because of its relative ineffectiveness for the purpose in hand.

Transportation costs can be regulated more cheaply by other means. There are two ways by which the transportation rates between the Middle West and the Atlan-

tic seaboard might be reduced at less cost than through the subsidizing of the waterway. The first is by the construction of an all-freight railroad, which could carry traffic at much lower costs than could the waterway. (See Chapter VIII.) Second, lower rates might also be secured through legislative means at an infinitesimal expenditure of public money as compared with what would be involved in constructing the waterway. Relief could be made effective by granting low rates on all commodities originating in the interior and intended for export,[5] and by granting low import rates on specified raw materials and finished products and on imported foodstuffs of a non-competitive character. Such an adjustment of rates on imports would have the advantage from the point of view of the Middle Western manufacturer of not subjecting the industries there to increased competition from Atlantic Coast and foreign manufacturers. It may also be observed that legislation requiring an adjustment upward of inter-coastal water rates would also restore the competitive position of the Middle West.

The St. Lawrence waterway would not be an effective agency for controlling railroad rates in general. Except in the case of grain and a few other items of traffic, the railroads would be under no compulsion to reduce their

[5] Since this was written we have had an instructive illustration of the possibilities. At the suggestion of the President the railroads have granted reductions in export rates on wheat effective from the latter part of May to September 30, 1929, running as high as 7 cents a bushel. Reductions have also been made on flour. While this is regarded as an emergency measure, it indicates the possibilities of reducing rates by other means than the construction of potential water routes.

rates. Our traffic analyses have indicated that the waterway would be able to compete for only a very small proportion of the traffic originating in or destined to the Middle West. This is true not only of high grade commodities but also of most of the less valuable commodities.[6]

Thus, even in cases where the waterway might be regarded as a potential competitor of the railroads it is not likely to be an effective regulator of rates. It may be safely stated that the railroads would themselves take no steps toward reducing rates by way of anticipation of the competition of the water route; not until traffic on that route had developed in considerable volume would they consider ways of winning it back. The reason for this is partly the sound business principle of not cutting prices until it is absolutely necessary to do so, and partly the fact that if the railroads reduced their rates at points where potential water competition existed, it would jeopardize their entire rate structure.[7]

For example, if rates were reduced at Detroit on account of water competition there, the rate disadvantage to the East, now sustained by industries situated in Lansing, Flint, Grand Rapids, and Kalamazoo, would be increased, and they would accordingly clamor for a reduction in charges. More serious, perhaps, would be the problem presented between Chicago, for example,

[6] For the specific factors applicable to each commodity, the reader must be referred to the several appendices.

[7] The Interstate Commerce Commission in fact now gives no recognition to merely potential water competition as a factor in rate regulation.

and the seaboard with rates lower than those applying at intermediate points, such as Pittsburgh, Columbus, Fort Wayne, and Indianapolis. These cities, nearer to the Atlantic seaboard and yet finding themselves paying higher rates, would demand relief, just as intermountain cities like Spokane have insisted that their rates should be lower, not higher, than rates to the Pacific Coast. If the Interstate Commerce Commission were to grant such demands, in whole or in part, the railroads would be in for a general readjustment of schedules. They would doubtless prefer to run the chance of losing some traffic for a few months each year at competitive lake ports than to meet the threat of potential competition by a cutting of rates. In view of our traffic analyses, we are satisfied that the railroads would not, except in a few special cases, cut rates to meet water competition. In the event that the Commission did not grant relief to the intermediate territories, we would tend to have a concentration of industry at lake ports as against these interior cities, which involves a question of national planning to which conscious attention should be given.

II. Relation of the Waterway to the Financial Condition of the Railroads

We must now consider the significance of the proposed St. Lawrence waterway from the point of view of maintaining the railroad systems in such strength and vigor that they can fully discharge their responsibilities to the public. We take up only the American phase of this problem at this point.

The waterway would not seriously affect the financial position of American railroads. In view of the conclusions heretofore reached as to the volume and character of the traffic that would be likely to make use of the St. Lawrence waterway,[8] it is clear that no important effects on the earnings of American railroads are to be anticipated. So far as general merchandise traffic is concerned, the diversion of traffic would be of very moderate extent and not sufficient to produce either an appreciable reduction of railroad earnings or a reduction of rail rates to hold the traffic to the rail lines. Our traffic analyses indicate a total of something like 5 billion ton-miles of United States traffic that might use the waterway, and of this total grain constitutes about 40 per cent, the greater part of which now moves east by water. (See Chapter VII.) In view of the fact that some of the other traffic included in our total estimates also now moves over the St. Lawrence route by water, something like 3.5 billion ton-miles represents the probable extent of outright traffic diversion from United States railroads. This is less than 2 per cent of the total traffic now carried by the railroads of the Eastern district, which in 1928 amounted to 183 billion ton-miles of revenue producing freight. The loss of revenues involved would clearly not be a matter of vital concern to the railways.

The rail carriers having their eastern termini at Lake Michigan or Lake Superior ports would not be adversely affected in any degree by the construction of the

[8] See Chapter VI.

waterway. On the contrary, they stand to benefit in proportion as the waterway proved effective. It has long been the view of these carriers that they have been accorded divisions of through rail rates disproportionate, distance and service considered, to those received by their eastern connections. The waterway would tend to render them independent of other groups of rail carriers. Also, if the new route proved effective as a carrier, it would tend to better the economic condition of the Northwest, where the growth of traffic in recent years has been perceptibly less than in most other parts of the country.

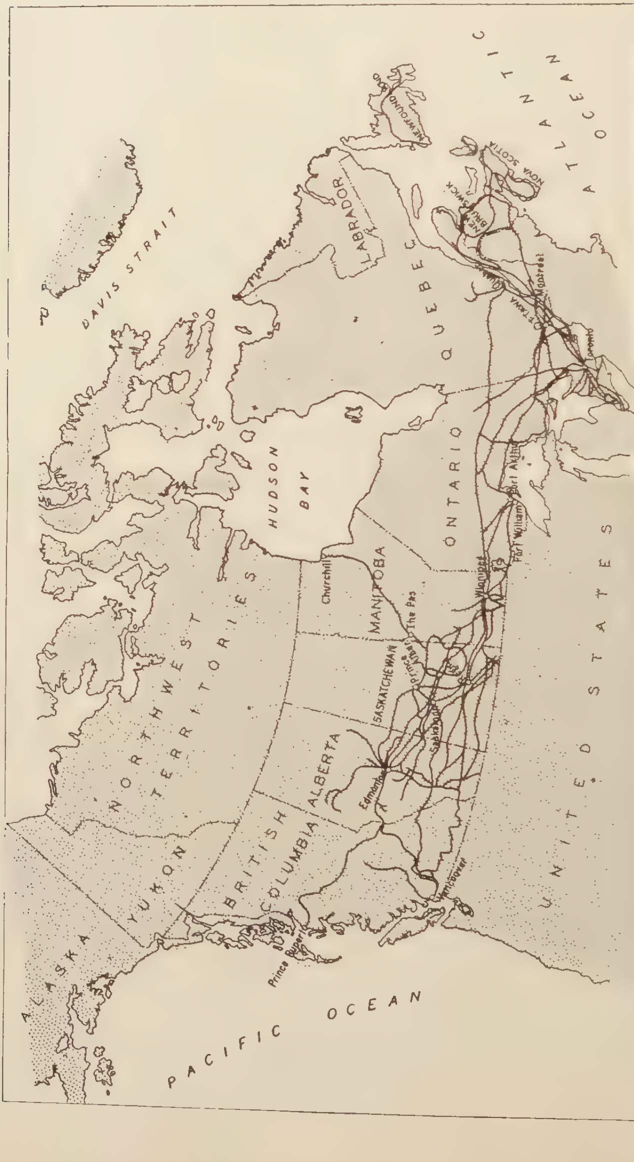
B. IN CANADA [9]

In considering the relation of the St. Lawrence waterway to the Canadian railway problem, we shall discuss first its significance as a regulator of railroad rates.

I. Relation to Canadian Railway Rates

The waterway would exert little influence on Canadian railroad rates. Much of Canada can be eliminated from consideration at the outset as being beyond the influence of the waterway. The Maritime Provinces and Quebec, British Columbia and much of Alberta are either on or near deep water today. (See map on page 192.) The Maritime Provinces and Quebec might, however, feel the effects of controlled railroad rates on certain traffic moving into the interior, such as coal and

[9] This section has been contributed by Professor D. A. MacGibbon of the University of Alberta.



Canadian Transportation Routes

heavy manufactures. The limited volume of such traffic is indicated on page 110, and more specifically in the several traffic appendices.

The waterway could exert no great influence upon railroad rates in lower Ontario, which is the diversified agricultural and manufacturing region of Canada. This region is not an important exporter of grain; and the other agricultural products such as dairy, poultry, livestock, and fruit are of such a character that little or no use would be made of water transportation. Our various traffic analyses have indicated that only limited quantities of the manufactured products of Ontario would move in export by water, and it follows that the waterway as a potential competitor would be relatively ineffective on such products. The minerals of Ontario are either of high intrinsic value, as cobalt, and so situated as not to be able to use the St. Lawrence, or they are of a character which destines them for purely local consumption, as iron ore and clay materials. Our individual traffic analyses indicate no considerable volume of either minerals or raw materials originating in Ontario that would find the St. Lawrence route advantageous. It is, therefore, a relatively ineffective means of regulating the level of railroad rates even on such traffic. Shipments from Ontario to upper lake points and beyond would have no occasion to make a round-about journey via Montreal.

The waterway would benefit the Prairie Provinces not so much by affecting railroad rates to the East, as by reducing present water rates in the stretch between the

lower lakes and Montreal. As indicated in the preceding chapter, the railways do not share in this traffic except during the late autumn, when some of the grain is transshipped to rail at Georgian Bay ports. The railroad rates to and from the Prairie Provinces are, moreover, exceptionally low, as a result of the Crow's Nest Pass Agreement reached in 1897 between the Canadian government and the Canadian Pacific Railway. The railroad agreed, in return for a subsidy of $11,000 a mile on a western division about 340 miles in length, to reduce rates from the east by about ten per cent on agricultural implements and building materials—commodities of which the settlers were in great need. Rates to the east on grain and flour, the export commodities, were also reduced. The other roads had to meet the level of rates set by this competition. In 1925 Parliament modified the act, making it applicable only on eastbound shipments.[10] Rates on grain and flour are thus still at the level set in 1897.

In any event, it is unnecessary for Canada to build a waterway for the express purpose of regulating rail-

[10] For the details and the history of this agreement, see Jackson, W. T., *Economics of Transportation*, 1926.

Efforts have recently been made to foster the movement of coal from Alberta to Ontario. The waterway would, however, work no change in the controlling factors in this situation. The out-of-pocket cost of moving this coal east is placed, by two members of the Canadian Board of Railway Commissioners, at about $7.22 per ton, the inclusive cost at $10.07, the cost with profit at $12.20. Another Commissioner puts the out-of-pocket cost at $6.50, while the Director of Statistics of the Canadian National Railways places it at $7.52. (*Traffic World,* October 8, 1927, p. 814). If the railroads were to charge rates merely sufficient to cover out-of-pocket costs, this coal could not compete in Ontario markets with coal from the United States and Nova Scotia.

road rates. The Canadian government, through its Railway Commission, has adequate control over the railway rate structure of the country. Whereas the St. Lawrence waterway would be a relatively ineffective agency for controlling the general railroad rate structure, and would be effective, if at all, during only a portion of the year, the Canadian Railroad Commission has the power to regulate rates on all types of traffic throughout the year and in the interests of the Dominion as a whole.

II. Relation to Financial Condition of Canadian Railroads

In order to appreciate the significance of the issue raised in this section, it is necessary to survey briefly the history of Canadian railroad development.[11] The present railway situation in Canada grows out of the national policy pursued between the years 1900 and 1915. During that period immigration was very large, expectations of extraordinary economic expansion were aroused, and a rapid growth of transportation facilities was encouraged. Two new transcontinental lines were planned and placed under construction. The Canadian Northern Railway began building eastward and westward from the prairie provinces, and the Grand Trunk Railway, under agreement with the Dominion government, started laying the rails for the

[11] For this history of Canadian railway development the reader is referred to MacGibbon, D. A., *Railway Rates and the Canadian Railway Commission,* chs. II-IV; and Jackson, *ibid.,* chs. I and XVIII.

Grand Trunk Pacific Railway from Winnipeg to Prince Rupert on the Pacific Coast. The Grand Trunk Railway also entered into agreement to operate the National Transcontinental Railway, which the Dominion government was constructing from Winnipeg to Moncton in New Brunswick. These projects were approaching completion when the war broke out in 1914. The net result was that between 1900 and 1915 railway mileage in Canada doubled.

The effect of the war was to check abruptly the inflow of immigrants who were expected to produce the traffic for the new lines. Failure of the expected traffic to develop, along with the derangement of commerce and finance occurring at the beginning of the struggle, soon placed these lines in very grave financial difficulties. The Canadian Northern succumbed first. The Grand Trunk Railway, through its obligations to its subsidiary, the Grand Trunk Pacific, was also soon in difficulties, and was unable to take over the operation of the National Transcontinental from Winnipeg to Moncton.

From a national standpoint the situation caused grave anxiety. In the first place, the country was vitally engaged in the prosecution of the war, and it was clear that if these railway systems were allowed to go through the ordinary routine of failure, the financial stability and credit of Canada would be profoundly affected. In the second place, to a large degree these enterprises had secured federal and provincial aid in the shape of construction subsidies, bond guarantees, and subsequently

of direct loans. The default in payment upon guaranteed bonds meant that the governments affected would be called upon to meet the interest charges. Under the circumstances the federal government deemed it wise to step in to avert a financial crisis and to protect its advances to the railways. This course was recommended to it by a Royal Commission of investigation which reported in 1917.[12]

The upshot was the organization of the Canadian National Railways to be operated by a Board appointed by the government of Canada. In addition to the railways above mentioned there was added to the system the Intercolonial Railway built by the Dominion government to the Maritime Provinces in fulfilment of the Act of Confederation. Substantially, the federal government consolidated what amounted to two transcontinental railway lines into one great but rather unwieldy system which, in 1927, comprised 19,299 miles of road.

Apart from the nationally operated Canadian National Railways there is in Canada the Canadian Pacific Railway with 14,074 miles of privately owned and privately operated lines. These two systems operate over 80 per cent of the railway mileage of Canada. The balance of mileage is represented by a number of local railways of no significance to the present study. The Canadian Pacific Railway and the Canadian National Railways compete against each other for traffic prac-

[12] *Report* of the Royal Commission to inquire into Railways and Transportation in Canada, Ottawa, 1917.

tically at every important point in the Dominion from the Atlantic to the Pacific.

The Canadian Pacific Railway, or the "C. P. R." as it is familiarly known, is a well-built line, splendidly equipped, with excellent traffic connections. It has a high reputation for competent management. In 1927 the ratio of its earnings to total expenses was 78.82 per cent, which may be compared with 74.65 per cent for American railways as a whole. The capital stock amounts to $624,393,000. But what especially distinguishes it is a relatively small funded debt, amounting in 1927 to only $35,650,000. The company is at present in a reasonably satisfactory financial condition.

On the other hand, the Canadian National Railway, as a legacy of the conditions under which the system was created, is heavily in debt. The capital stock in 1927 was $1,839,956,551; the debenture stocks, $541,-805,794; and the funded debt $2,179,186,587. The company has continuously failed to meet its operating expenses plus fixed charges. Since 1923 revenues have more than covered operating expenses, but they have failed to meet fixed charges by the following amounts:

Year	Deficit
1923	$51,697,675
1924	54,860,419
1925	41,444,764
1926	29,701,445
1927	34,373,027
1928	24,730,410

Owing chiefly to economies of operation, resulting in part from the completion of consolidations, earnings have been steadily increasing, but it is still a matter of

serious concern to a debt burdened government faced with an insistent demand for a reduction of the load of taxation.

The St. Lawrence waterway would tend to increase the financial difficulties of Canadian railways. In view of the Canadian government's financial responsibility for covering the deficits incurred by the Canadian National system, it is impossible for those responsible for the planning and administration of Canadian affairs to ignore the possible effects of the St. Lawrence waterway upon government finances. The supreme need of the Canadian railways is a larger volume of traffic. Public men of all parties in Canada have recognized that this will not be forthcoming except through the productive efforts of increased population. To hasten the arrival of fundamental relief an energetic policy designed to increase immigration has been strongly urged. Railway executives have repeatedly pointed out the connection between increased population and a solution of Canada's railway difficulties. In assuming the presidency of the Canadian National Railways, Sir Henry Thornton, in his first public address, declared: "How soon the Canadian National Railways will become self-supporting turns largely on what is done in the matter of immigration." [13] Indeed, in recent years, the problem of securing increased population in Canada, in order to lighten the burden of taxation and transportation charges, has been so much discussed that it has become almost a national obsession. Unfortunately as

[13] Address before the Montreal Board of Trade, Dec. 5, 1922.

already noted population has not been increasing in recent years.

It is perfectly obvious that if the St. Lawrence route diverted an important volume of traffic from the Canadian National, it would nullify the results expected to be obtained from increased population as a method of solving Canada's railway problem. To the extent that it reduced the flow of traffic available for the railway it would prolong the period before it could be reasonably expected that the Canadian National Railway system would pay its way. For a longer period the system would be a drain upon the finances of Canada and to that extent there would be postponed the possibility of relief from excessive taxation.

Nor would the financial status of the Canadian Pacific Railway remain unaffected. The consolidation of several weak railway enterprises into the Canadian National Railways has naturally sharpened the competition with which the Canadian Pacific Railway has had to contend in recent years. Owing to its excellent organization and traffic connections it has, however, maintained its volume of traffic and earning power. If it should lose a considerable volume of traffic to the proposed waterway, its earnings would accordingly be reduced. The loss of such earnings, while it probably would not endanger the financial stability of the road, would make it difficult for it to maintain its present high standards of equipment and of service. Nor would it be as easy for the Canadian Pacific Railway to secure additional capital when it became desirable for the

system to extend its lines into certain sections of Canada which as yet remain undeveloped but in the future undoubtedly will require railway facilities. The effects of the waterway upon railroad earnings in Canada would be very much greater than in the United States because of the much lighter traffic available for Canadian railroads and because the diversion of traffic to the waterway would be relatively greater.

Certain ramifications of the problem remain to be considered. The rates charged upon the Canadian railways are, as we have noted, under the control of the Board of Railway Commissioners for Canada. The Board early accepted as a canon of judgment the view that railways shall be allowed to earn a fair return upon the capital invested. On account of the overbuilding of railway lines the principle has been difficult to apply, but in effect it has meant that the rates validated have permitted the privately owned road to earn a fair return. In a recent case, the Chief Commissioner expressed the government's responsibility in the following language, " . . . . it is the duty of the Board to protect and preserve the railways in their financial operations by allowing rates reasonable and fair to them." [14]

Now if the construction of the St. Lawrence route, by diverting traffic, or by forcing reductions in rates on certain commodities, should materially reduce the earnings of the Canadian Pacific Railway in Eastern Canada, the company would naturally seek to increase

[24] 13 B. R. C. 131, 156 (1927); also p. 135.

its earnings by higher rates in that part of the Dominion where the railways are not subject to water competition; that is, in the Canadian northwest. What would be sound policy for the Canadian Pacific Railway would also be sound policy for the nationally owned system. It is conceivable that an increase of rates in the Prairie Provinces might enable the railways to recoup themselves for losses on account of the waterway sustained in the Provinces of Ontario and Quebec.

The difference in rate levels between eastern and western Canada, particularly the farther west, has, however, long been a source of great complaint in the western provinces. In fact, the matter has been a subject of political controversy and much consideration has been given by the government to the demands for equalization in rate levels between the various provinces. Concessions have been made to the demands of the west in a long line of decisions by the Board of Railway Commissioners, each of which has tended to lessen the "spread" between eastern and western rates.[15] The needs of relieving agriculture and of equalizing eastern and western rates have also frequently found expression in statements of policy by the Privy Council.

If, in the interest of recouping railway losses occasioned by a diversion of traffic to the waterway, rates should be raised in western Canada, the difficulty of obtaining ultimate relief for the railroads through an increased population and an enlarged volume of traffic

[15] For summary, see *Report* 15, Board of Railway Commissioners, pp. 333, 351-58.

would be increased. To raise the level of rates in western Canada would tend to check the flow of immigration into the undeveloped lands of the western provinces. Such a development would thus make more remote the improvement in the railway situation that is ardently hoped will result from an ultimate increase in the agricultural population of Canada.

CHAPTER X

THE ST. LAWRENCE WATER-POWER PROJECT

The analysis thus far has been confined solely to the transportation phase of the proposed St. Lawrence development. It remains to consider the power aspect of the project. In the view of some of its advocates, the St. Lawrence project should be considered primarily as a power enterprise with transportation only an incidental consideration. Accordingly, in this chapter we shall survey the economic possibilities of the hydroelectric developments that have been projected.

I. THE PROPOSED POWER DEVELOPMENT

The character of the power sites and the proposed plans for development will be briefly described. The St. Lawrence receives from the Great Lakes an average flow of 246,000 cubic feet of water per second (mean discharge for a period of 66 years). This enormous flow falls an aggregate distance of 226 feet in the 183 miles between the lower end of Lake Ontario and Montreal Harbor. This total fall, or "head," is concentrated, however, principally in three sections of the river (see map opposite p. 26), the International Rapids, the Soulanges, and the Lachine section. The International Rapids section extends from Ogdensburg, N. Y.

to Cornwall, Canada, a distance of 48 miles. Through this section the river runs in a long series of rapids, falling 92 feet in the 48 miles. The Soulanges section extends for a distance of 18 miles just above the mouth of the Ottawa River. The fall of the river through this section is concentrated in three sets of rapids, the Coteau Rapids, the Cedar Rapids, and the Cascade Rapids. The total fall, or "head," for this section is 83 feet. The Lachine section is just above Montreal Harbor. Here the river falls 48 feet in a distance of 24 miles.

The Engineering Board's recommendations as to power developments are based on a scheme looking toward the ultimate utilization of the full energy resources of the river, taking into account the necessary regulation of flow required to maintain navigation. The complete power development visualized by the Board calls for the construction of three or four dams across the main channel of the river, with incorporated power plants, and three power plants fed by headrace canals. The power plants, when completed and fully equipped to utilize the maximum flow available at the several power sites would have an aggregate capacity of approximately 5,000,000 horse power. The magnitude of the power resources of the St. Lawrence can be realized by comparing this estimate of 5,000,000 horse power with other hydroelectric projects. The total installed capacity of existing power plants at Niagara Falls on both sides of the river is only a fourth of this amount, or 1,250,000 horse power. The full power

potentiality of the Muscle Shoals site is estimated at 875,000 horse power.

Taking into account a "conservative estimate of the rate at which power can be marketed under restrictions as to exportation," the Board recommends the initial construction of power houses with an aggregate capacity of 2,619,000 to 2,730,000 horse power. It further recommends for consideration the advisability of the initial installation of machinery to develop one-half of this amount of power.

In the *International Rapids section* it is proposed to make improvements for power in conjunction with the improvement of the river for navigation. This will be done by damming the main channel of the river at the foot of the rapids; thereby drowning out the rapids, creating a slow flowing pool for navigation, and concentrating the "head" for power development. The power houses will be incorporated in the dam, and navigation will be carried on by means of a side canal around the dam. The Board estimates that something over 2,000,000 horse power can be developed in this section, and recommends the initial installation of machinery to develop approximately one-half of that amount.

The Soulanges section, if developed as recommended by the Board, will have, when fully completed, three power plants with an aggregate capacity of nearly 2,000,000 horse power. For immediate use the Board recommends the construction of a power plant with an initial installed capacity of approximately 200,000 horse power, at an estimated cost of approximately

$84,000,000.[1] The Board recommends a progressive program of development in this section as follows:

The first power development will be made in conjunction with the improvement of this section of the river for navigation. The power plant will be incorporated in a dam across the river at the head of Cedar Rapids. This plant will have a maximum installed capacity estimated at 404,300 horse power, one-half of which is recommended for installation at the time the St. Lawrence route is opened to navigation.

At such a future date as the potential market for hydroelectric energy seems to justify it, a second power plant will be installed in this section. This plant will be on the Canadian side of the river and will be located north of Cascade Rapids. It will be supplied by a head-race canal and will have an installed capacity estimated at 545,000 horse power.

As the market for power grows, there is visualized a third power plant, incorporated in a dam at the foot of the Cascade Rapids, with an estimated capacity of a little more than 1,000,000 installed horse power or 750,000 kilowatts.

The Lachine section, according to the plan of the Engineering Board, will have eventually a total hydroelectric power development estimated at 923,000 installed horse power. The improvement of this section for power will be practically independent of improve-

[1] This figure includes the costs incurred jointly for navigation and power, and is built up from the engineers' estimate by the method discussed in Chapter V.

ments for navigation and no power plants are recommended for immediate construction.

It will be seen that the potential St. Lawrence power lies partly between Canadian and American territory and partly within Canada. We may assume that one-half of the power in the International section, amounting roughly to one million installed horse power, would belong to the United States government. The value of this American power is discussed in Section III below. The Canadian attitude with reference to the power project, and the potential markets in Canada for the energy developed in the River is discussed in Section IV.

II. MARKET POSSIBILITIES IN THE UNITED STATES

In none of the official reports on the St. Lawrence waterway has there been an analysis of the economics of the power phase of the project. The Joint Board of Engineers limited its investigation to the cost of power developments on the river and the amount of energy that could be generated; and the several commissions which have studied the problem have apparently taken it for granted that the power could be sold for at least enough to cover the cost of its development. There has been no careful appraisal of market possibilities.

There are two ways of going about an analysis of the value to the United States of the St. Lawrence power development. The first, which may be called the straight commercial method, would start with costs of produc-

tion, with a view to arriving at a price at which the energy could be sold in the market and yield a reasonable return on the investment. It would involve figuring the cost both of developing the energy at the river, and of transmitting and distributing it, including under costs all of the items which are ordinarily included by private enterprise. The feasibility of the power development would then depend upon whether the rate that could be charged on the basis of the inclusive costs would be low enough to meet competition from other sources of power.

We have had an investigation made on a straight commercial basis by the engineering firm of Sanderson and Porter. Their report is presented in full in Appendix K. The costs of generating and transmitting the St. Lawrence power to various potential markets, and the other data used in the analysis below, are taken entirely from this report of Sanderson and Porter.

The second method and the one which we shall follow in this chapter is to ascertain the price at which the St. Lawrence energy would have to be sold in order to meet the competition of steam generated energy and then to ascertain what revenue would be available for the government after meeting the costs of transmitting this energy from the power plants on the river to the markets. If the amount exceeds the *annual* cost of developing the power, this phase of the project will have to be pronounced economically profitable; if it is less than the annual cost of production it will have to be pronounced economically indefensible.

There are alternative plans for marketing this power. The first, and until recently the only plan involves transmission over an independent transmission system to single markets capable of absorbing practically the entire output; and the second involves distribution to various localities through interconnection with a general power system. It is desirable to consider each method separately.

Sanderson and Porter find in their analysis that the only accessible markets capable of absorbing as much as 1,000,000 horse power will be the metropolitan area of New York City and the Boston-Worcester region. There is, however an alternative source of energy available for the New England district in the undeveloped waterpower of Maine, recent investigations having shown that there is a possibility of low-cost developments in that state amounting to approximately one million kilowatts of capacity. At present the State of Maine prohibits the exportation of electric energy. Such a restriction might, however, at any time be removed, and there has in fact been considerable agitation for its removal. In any event, in view of the possibility that the future power requirements of Massachusetts might be met from this alternative source, we shall center our attention upon the market in the metropolitan area of New York. This restriction of the discussion is of no particular consequence, since the conclusion reached by Sanderson and Porter is substantially the same for the New England district as for the metropolitan area of New York. (For detailed data, see Appendix K.)

III. THE POTENTIAL REVENUE TO THE UNITED STATES GOVERNMENT *

The competition which the St. Lawrence hydroelectric energy would have to meet in the New York metropolitan area would be that from large steam electric plants. To ascertain the price at which energy from the St. Lawrence must be sold to distributing agencies in New York City in order to supplant steam generated energy, it is necessary to compute the cost of generating an equivalent amount of energy by steam electric plants in the vicinity of New York.

The amount of energy that could be delivered to New York is estimated by Sanderson and Porter at 3,720,000,000 kilowatt hours annually. The United States power plants at the International Rapids section of the river would have, as we have seen, an installed capacity of approximately one million horse power, and it is estimated that these power plants might generate as much as 4,900,000,000 kilowatt hours per year. The normal, or average, output deliverable at the river to the United States transmission lines (after the delivery of approximately 500,000,000 kilowatt hours to the Aluminum Company of America), is estimated at 4,380,000,000 kilowatt hours. A generating plant with an output of 4,380,000,000 kilowatt hours could, after allowing for losses in transmission, thus deliver to the New York metropolitan area approximately

* For this analysis it is assumed that the project is to be developed by the United States government rather than by the State of New York. No position is taken with reference to the rights of the latter.

3,720,000,000 kilowatt hours per year. (See Appendix K, page 654.)

A modern steam-electric plant could, under present conditions, generate 3,720,000,000 kilowatt hours of energy per year for delivery to distributing lines in the metropolitan district of New York at an estimated annual cost of $21,000,000, or at the rate of 5.69 mills per kilowatt hour. This would cover charges against capital investment in land, structure, water supply and equipment, and the operating expenses. (See Appendix K.)

The trend of unit costs in steam plants, owing chiefly to technical improvements, has shown a phenomenal decline in recent years, and it is believed by competent authorities that this downward trend will continue, though at a decreasing rate. The decline in fuel consumption per kilowatt hour since 1913, with a projection of the curve to 1935, is shown in Appendix K, page 666. If no change in the general level of prices occurs, the cost of steam generation a decade hence will, according to competent authorities, be less than 5.0 mills. A price of 5.25 mills per kilowatt hour would allow for a possible rise of 10 to 15 per cent in the price of coal. The fact should be mentioned that the chance of reducing the cost of transmitting hydroelectric energy does not appear to be great.[2] Moreover, hydroelectric generation is already so near to 100 per cent efficiency that but slight further reduction in costs is possible.

[2] See Appendix K, p. 667.

This rate of 5.25 mills may be taken as the maximum price at which St. Lawrence energy could be sold in New York in competition with steam generated energy. In order to ascertain the revenue which the government could obtain from the St. Lawrence energy, it is necessary to subtract from this figure of 5.25 mills per kilowatt hour the unit cost of transmitting energy from the government power plants on the river to the metropolitan area. The transmission of the St. Lawrence energy from the river to the markets might be conducted either by the government itself or by commercial companies. Discussions of the project have assumed that the government's direct concern with the problem will be confined to the developments on the river. In the nature of the case, the power development along the St. Lawrence must be under government auspices.[3] But the question as to whether the government is to operate the power plants and also to develop and operate transmission lines is a question of public policy which need not be here considered. We shall here follow the usual assumption that the transmission and the distribution of this energy will be carried out through private agencies. Accordingly, the revenue which the government would receive will be 5.25 mills per kilowatt hour, less the amount it would be necessary to pay a commercial company for transmitting a kilowatt hour of energy from the government power plants on the river to the distributing agencies in the New York market.

[3] See, for example, the bill sponsored by Governor Roosevelt of New York for the development of this power under state auspices.

The metropolitan district of New York, which may be considered as a potential market for St. Lawrence electric energy, embraces a wide territory, including that now served by the Public Service Company of New Jersey and the Brooklyn Edison Company, as well as the territory served by the New York Edison Company and its associated companies. The distance from the power site on the International Rapids section of the St. Lawrence to the metropolitan district is approximately 334 miles. To deliver St. Lawrence energy to the metropolitan district, it would be necessary to transmit it over high-voltage transmission lines to sub-stations in the vicinity of New York, and there to transform it to lower voltages for delivery to the distributing systems of New York electric companies.

Plans for a transmission system, as worked out by Sanderson and Porter, call for three widely separated rights-of-way—each with two independent circuits for transmitting St. Lawrence energy at a high voltage to sub-stations in the vicinity of New York. (See chart, page 651, for the location of transmission lines.) Two sub-stations would be required: one located near Elmsford, about 20 miles north of New York City, and one in the vicinity of Newark. From the Elmsford sub-station a connection would be made to the nearest New York City steam station of the New York Edison Company. Energy transmitted to the Newark sub-station, it is assumed, could be delivered directly to the distributing lines of the Public Service Company.

To install such a transmission system would involve the purchase of rights-of-way, the erection of towers and high-tension cables, the building and equipping of sub-stations, and the laying of underground cable connections from the sub-station at Elmsford to the New York City distribution system. The capital cost of such a system, Sanderson and Porter estimate at $85,300,000, and the annual charges at a total of $11,100,000 for an annual delivery of 3,720,000,000 kilowatt hours. This annual charge gives us a transmission cost of 2.98 mills per kilowatt hour of energy delivered to the metropolitan district. (See pages 655, 660.)

It would also be necessary to provide for reserves and emergency requirements. In other words, to make the St. Lawrence power of "equivalent service value" with steam power, a relay steam plant having a capacity of approximately 50 per cent of the hydroelectric energy would be necessary. To provide such a reserve would necessitate an increase in the cost of the hydroelectric power of 1.23 mills per kilowatt hour of energy sold.[4]

It should also be noted that there would be certain losses involved through displacement of steam power. It has been assumed in the foregoing analysis that the metropolitan district would be large enough to absorb the total amount of energy produced in the International Section of the river. While this is true, it must be borne in mind that the power needs of the metropolitan district have to be supplied continuously; and hence

[4] See Appendix K, p. 668.

at the time the St. Lawrence power became available the market would presumably be adequately supplied from steam generating plants. There would thus be a period of several years during which only a portion of the energy that might be developed from the St. Lawrence could be marketed at the prevailing price, or during which the hydroelectric energy would have to be sold at less than the prevailing price in order to get the market. While such considerations as these cannot be ignored from a practical commercial point of view, we shall not take them into account in figuring the potential value of this St. Lawrence power.

From the above analysis we reach, then, the following conclusion. Subtracting 2.98 mills (the cost of transmission) from 5.25 mills (the probable selling price in New York) we get 2.27 mills as the maximum price which the government might obtain per unit of energy delivered. For the 3,720,000,000 kilowatt hours which could be delivered to the New York market annually, this rate would yield to the government an annual revenue of $8,444,000 as the maximum possible.

We shall now compare the revenue which the government might derive from the sale of this energy with the annual cost of generating it. The estimated cost of generating this energy is shown in the tabulation on page 217.

In this computation we have assumed that the transportation enterprise is not economically justifiable and that in consequence all of the so-called joint costs for navigation and power would have to be charged against

power. The reader will bear in mind that these costs remain practically the same whatever their allocation as between power and navigation, and that there are

ANNUAL COST TO UNITED STATES OF GENERATING ELECTRIC ENERGY IN INTERNATIONAL RAPIDS SECTION [a]

Capital Investment:		
United States share of joint navigation and power costs ($106,500,000) . . .	$53,250,000	
United States share of costs solely for power	54,750,000 [b]	
Interest during construction, at 4 per cent, for 4 years	20,700,000	
20 per cent for underestimates	21,600,000	
Total United States Investment.		$150,300,000
Annual Charges on United States enterprise:		
Interest on investment at 4 per cent. .	6,000,000	
Amortization at 1 per cent	1,500,000	
General expense	500,000	
Operation	750,000	
Maintenance and renewals	1,000,000	
Total Annual Cost of Generation.		$9,750,000

[a] The estimated capital investment is in the main taken from the *Report* of the Joint Engineering Board, but we have made certain additions to this for reasons explained in Chapter V. The estimated annual operating expenses are taken from Sanderson and Porter's analysis, Appendix K, p. 640.

[b] This figure varies slightly from that given by the Joint Board of Engineers. It is taken from Sanderson and Porter's estimate, Appendix K, p. 638.

certain additional costs directly chargeable to power and certain ones directly chargeable to navigation.[5]

The proceeds from the sale of this power, when transmitted over an independent transmission system, would not cover the costs involved for the government. The

[5] See Chapter V for the latter.

total estimated annual revenue is $8,444,000 and the total estimated annual expenditures are $9,750,000, leaving a deficit of $1,306,000 annually. From the table on page 640 it will be seen that we assumed the interest on the capital investment to be at the low rate of 4 per cent annually—on the theory that the funds would be raised on government credit. If the rate were as high as 5 per cent, this deficit would be increased by $1,500,000.

This deficit of $1,306,000 annually does not measure the full extent of the loss involved to the government, since one very important item of expense has not been included in the table above, namely, taxes and license fees. If the government were to lease the power works to a private company for operation, such a company would have to pay to the state and Federal governments in taxes and license fees something like $1,660,000 annually, and these would have to be included as elements of cost.[6]

And even if the government were to operate the plant and transmit the power itself, these taxes and license fees cannot be ignored as an element of indirect cost. From a broad economic point of view, taxes and license fees which are foregone by the government when it develops business enterprises must be considered as an offset to the revenues which it would collect if the same business were developed under private enterprise. If, for example, the New York area is furnished energy from steam electric plants near at hand, the producing

[6] See Appendix K, p. 640.

companies would of course contribute, out of the funds received from the sale of energy, their quota of taxes. Taxes and license fees must, therefore, be included in any attempt to appraise the economic value of the power development on the St. Lawrence. The total annual loss involved would thus equal $2,966,000 annually. This figure does not make allowance for the cost of the necessary reserves in generating capacity estimated above at 1.23 mills per kilowatt hour.

We must now turn to a consideration of the possibilities of disposing of the St. Lawrence power in a number of markets by means of inter-connection with a regional power system. In the report of Sanderson and Porter, it is pointed out that there appears to be in process of combination under one directive control most of the important power systems from Niagara across New York State to New England, and also south to New York City and other points along the Atlantic seaboard. Sanderson and Porter conclude that if 50 per cent or more of the St. Lawrence power could eventually be sold to electrochemical and electrometallurgical industries at the river, the remainder might be fed into an inter-connected power system at Utica for distribution in New York and to points south, and at Hoosic for distribution in New England. The probable electrification of the New York Central Railroad during the next ten years would create a demand in upstate New York for one billion kilowatt hours, leaving roughly another billion to be distributed south and east from Utica and Hoosic.

Such portion of the power as could be marketed at the river would, of course, involve no transmission costs. The cost of transmission from the river to Utica and Hoosic would be about 1.71 mills as against 2.98 mills over an independent system to New York City. The re-transmission from Utica and Hoosic over an inter-connected system would involve costs somewhat smaller than would be the case if independent lines had to be constructed. Thus if a major portion of the power could be used at the river at 3.5 mills per kilowatt hour, and a billion kilowatt hours in upstate New York, at 5.2 mills, with the remainder taken into an inter-connected system at Utica and at Hoosic, also at 5.2 mills, then the cost of the power development would be covered by the returns received.

The major question involved appears to be whether the existence of this St. Lawrence power would attract a large industrial development at the river. With most industries the cost of power is not a major element in the total cost of production, and numerous other factors such as labor supply, nearness to raw materials and markets, are more important considerations in the determination of location. With electrochemical and electrometallurgical industries the cost of power is of more decisive importance. If the St. Lawrence power at 3.5 mills (the cost of generation) proved to be substantially cheaper than could be obtained elsewhere, an extensive development of such industries along the river might eventually be expected. An important factor in the

situation is the severity of the competition that may be expected from Canadian power; and to the Canadian phase of the problem we must now direct our attention.

IV. CANADA'S INTEREST IN THE ST. LAWRENCE POWER

When fully developed, the St. Lawrence River will provide Canada with an installed capacity of nearly 4,000,000 horse power, approximately four times the potential power provided for the United States. This figure includes Canada's share of the power available in the International Rapids section, approximately 1,000,000 horse power of installed capacity; all the potential power available in the Soulanges section, about 2,000,000 horse power; and all that in the Lachine section, equivalent to some 900,000 horse power. Translated into terms of kilowatt hours, the energy available to Canada from the St. Lawrence, if utilized with a load factor similar to that assumed for the United States share of the power, is in excess of 17,500,000,000 kilowatt hours annually. As was pointed out in Chapter V, the project under immediate consideration by the governments of Canada and the United States is concerned chiefly with the power available in the International Rapids section. (As noted earlier, the project calls for the development of a small block of power in the Soulanges section.) The cost of the major developments in the lower river, estimated at $225,000,000, is of course not included in the cost of the joint Canadian and American project.

As a matter of national policy Canada is opposed to the export of hydroelectric energy. The desirability of exporting power has been a subject of debate for many years in Canada. Exportation is now opposed not only by the Provinces of Ontario and Quebec but generally throughout the Dominion. The Canadian Parliament has finally laid down a national power policy which limits the future exportation of hydroelectric energy to operations under a yearly license, and permits the granting of no new license without the consent of the province or provinces concerned. In the recent correspondence between the governments of Canada and of the United States, it is stated:

> Public opinion in Canada is opposed to the export of hydroelectric power, and is insistent that such power as may be rendered available on the St. Lawrence, whether from the wholly Canadian section or from the Canadian half of the International section, shall be utilized within the Dominion to stimulate Canadian industry and develop the national resources.[7]

In brief, the Canadian opposition to the export of energy is based on the conviction that Canada would thereby be giving "United States industrial competitors the use of the most efficient tool in the kit bag of the Canadian industrial." In the light of this national policy, we must confine our discussion to the possibility of marketing the St. Lawrence energy within Canada. This necessitates a consideration of Canada's other hydroelectric resources.

[7] Note of January 31, 1928, from the Canadian Minister to the Secretary of State. See Appendix A.

Only about 11 per cent of Canada's water power resources have as yet been developed. These resources for the various provinces of Canada are shown in the table below.

It is pointed out in the government document from which this table is taken that "the installations at

AVAILABLE AND DEVELOPED WATER POWER RESOURCES IN CANADA [a]

Province	Available at Ordinary Six Months Flow (horse power) [b]	Turbine Installation (horse power)
British Columbia	5,103,500	473,062
Alberta	1,049,500	34,107
Saskatchewan	1,082,000	35
Manitoba	5,344,500	255,125
Ontario	6,940,000	1,827,088
Quebec	13,064,000	2,165,443
New Brunswick	120,800	47,231
Nova Scotia	128,300	65,702
Prince Edward Island	5,300	2,274
Yukon and Northwest Territories	275,300	13,199
Total	33,113,200	4,883,266

[a] See "Water Powers of Canada", *Water Resources Paper, No. 60*, Department of the Interior, Canada, 1927, p. 13.
[b] 24-hour power at 80 per cent efficiency.

developed sites exceed the estimates of ordinary six-month power at such sites by about 30 per cent. On this basis the total recorded resources of Canada would warrant the installation of about 43,000,000 horse-power. In other words, the present turbine installation represents slightly more than 11 per cent of the total resources." Moreover, the present installed capacity is only approximately 25 per cent in excess of the amount

of power that will be available to Canada from the St. Lawrence alone when it is fully developed.

The province of Quebec has the largest installed capacity at present and also the largest future undeveloped resources. In brief, Quebec has a present installation (November 1, 1927) of 2,165,443 horse-power, and 14,700,000 horse-power of potential power resources, including that in the St. Lawrence. The Ottawa River and its Quebec tributaries provide power possibilities of from 1,000,000 to 1,600,000 horse-power, and the Saguenay has total resources of 1,260,000 to 1,530,000 horse-power. The remainder is scattered among a large number of smaller streams of the province.

Ontario's turbine installation amounts (November 1, 1927) to 1,827,088 horse-power. Potential additional resources amount to about 7,000,000.[8] Of the undeveloped water power of Ontario, from 600,000 to 1,000,000 horse power is in the Ottawa River along the provincial boundary, and the remainder is found chiefly in the various streams entering Lake Huron (from 220,000 to 413,000 horse power), Lake Superior (180,000 to 300,000 horse power), and Hudson Bay (from 750,000 to 1,330,000). The principal power sites in the rivers flowing into Lake Erie and Lake Ontario have been developed.

As was pointed out in Chapter I, there is a conflict of interest and of view in Canada as to the advisability of the Dominion government's entering into an agree-

[8] Estimated on the basis indicated in the paragraphs above.

ment with the United States for the development of the St. Lawrence power. In Quebec, the development of power resources has been conducted by private enterprise, on the basis of government leases. Both the government and the power companies are therefore in opposition to the development of the St. Lawrence power under the auspices of the Dominion government. They feel that the development of such vast resources of power would compete with their own power enterprises, and curtail for many years to come their possibilities of growth.

In the Province of Ontario, the situation is different by virtue of the fact that power development is dominated by the Hydro-electric Power Commission of the Province. The Commission naturally favors the development, under government auspices, of the power in the International Rapids section of the St. Lawrence. The Commission takes the stand that the Ontario market is capable of absorbing this power as rapidly as it can be developed. "Viewing the future power markets in the light of present information, it may be stated that . . . . by 1935 or 1936 the whole of Ontario's share of the St. Lawrence River power would probably be absorbed by the Ontario markets alone." [9]

The present consumption per capita of electric energy in Canada is approximately double that of the United States. We present below the annual consumption per capita for the United States and for Canada as a whole,

[9] Statement in *Engineering Report* by the Hydro-electric Power Commission of Ontario, submitted to the International Joint Commission, 1925, p. 21.

for the Provinces of Ontario and Quebec and for the State of New York. The figures are estimates for the year 1926.

	Kilowatt hours
United States	630
Canada	1288
Province of Ontario	1692
Province of Quebec	1951
State of New York	1002

In Canada as a whole the consumption per capita of electric energy is almost exactly double that in the United States, notwithstanding the greater industrial demand on the American side of the border. In Ontario and Quebec the consumption is nearly double that in New York State. The estimate of the Ontario Hydro-electric Power Commission that Ontario markets alone can readily absorb all the power of the International Rapids section as soon as it could be made available is obviously based on the assumption that a rapid industrial development in Canada fostered by cheap power is assured.

The problem in Ontario is not essentially different from that in connection with the United States share of the power to be generated in the International Rapids section. Its sale will in the main depend upon the development near the river of industries which will utilize the power at a high-load factor. The same is true for the power available in the lower river which lies within the Province of Quebec. It will be apparent, moreover, that American and Canadian power will be competing for electrochemical, electrometallurgical, and other industrial development along the river.

The conclusion indicated by the foregoing analysis is that from the standpoint of neither the United States nor Canada is great haste required in the development of the power resources of the St. Lawrence River. That this power will eventually be exploited and utilized on an economical basis is scarcely to be doubted. Just how rapidly the necessary industrial development along the river will come, no one is in a position at the present time to forecast.

CHAPTER XI

SUMMARY AND CONCLUSIONS

In analyzing so comprehensive a problem as that presented by the St. Lawrence navigation and power project, it has been necessary to divide the discussion into a number of more or less separate parts. In this final chapter we must, therefore, draw together the various threads of our analysis and present the conclusions to which the investigation as a whole appears to lead. It will be necessary to indicate certain general conclusions with reference to the project conceived as a single enterprise, and also to consider it separately from the point of view of Canada and the United States respectively.

1. *Costs.* The cost of the project may be summarized in round numbers as shown on following page—the costs incurred jointly for navigation and power being allocated entirely to power.

In addition, the development of the potential power available in the lower St. Lawrence, wholly within Canada, would cost, according to tentative estimates submitted by the Joint Board of Engineers, approximately $225,000,000.

2. *Power.* Our analysis indicates that, although the development of the St. Lawrence hydroelectric energy will in the course of time doubtless be economically

profitable, its exploitation at present would be premature. The United States share of the energy to be developed in the International Rapids section could not be disposed of in existing markets at a price sufficient to cover its cost of production and distribution. Its profitable marketing in the future will depend primarily upon an extensive industrial development, particularly in

For Navigation		
Improvements in St. Lawrence River...	$159,000,000	
Improvements in inter-connecting lake channels	90,000,000	
Improvements in lake harbor and port facilities [1]	250,000,000	
Welland Ship Canal (under construction by Canadian Government)	115,000,000	
Total		$614,000,000
For Power		
Improvements in International Rapids section	301,000,000	
Improvements in Soulanges section	84,000,000	
Total		$385,000,000
Combined Navigation and Power Costs.		$999,000,000

electrochemical and electrometallurgical lines, along the American side of the river. The conclusion with reference to Canada's enormous power resources in the St. Lawrence is similar. The profitable sale of this energy will depend upon great industrial expansion on the Canadian side of the river. Canada has great additional power resources which many believe should be developed before tapping those of the St. Lawrence.

[1] This expenditure would of course incidentally benefit lake shipping.

The power project should not be expected to subsidize navigation. In discussions of the proposed St. Lawrence development, it has frequently been stated that the revenues derived from the sale of hydroelectric energy would be sufficient not only to cover the cost of the power development but also to meet the capital costs for navigation as well. We have seen that such a conclusion is quite unwarranted. Even were there excess returns from the sale of water power, it by no means follows that such revenues should be used to support navigation. The navigation project must stand on its own feet, at least to the extent that costs have to be incurred solely for the purposes of navigation. With the so-called joint costs allocated entirely to power, the navigation costs, as we have seen above, still amount to a total of $614,000,000. The governments of Canada and the United States will be justified in incurring these costs only provided they will lead to a reduction in the cost of transportation.

3. *Shipping.* The investigation has shown that a 27-foot channel would limit the use of the route to vessels of the type engaged in the coastwise trade and to the smaller trans-oceanic freighters, chiefly tramps and the war-built United States Shipping Board boats. A depth of 33 feet would be necessary if the route were to accommodate first class steam and motor-driven cargo vessels of the type which proponents of the waterway have ordinarily assumed would use it.

Our analysis of the shipowners' problem indicates that first class cargo liner service would not be es-

tablished between lake ports and world markets, even if an adequate depth of channel were provided. This is primarily due to the difficulty that ocean vessels would encounter in finding remunerative employment during the five and one-half months that the St. Lawrence route would be closed to navigation each year. At the most, we could expect coastwise vessels and tramp steamers to utilize the route and possibly a second class liner service to develop between lake ports and Europe. Our analysis of the character of traffic available lends strong support to this conclusion.

4. *Traffic.* Our traffic analyses have shown that the total traffic likely to make use of the proposed St. Lawrence waterway would probably not exceed 10,500,000 tons a year. This figure includes certain local traffic along the River as well as that which would pass between lake cities and coast or overseas ports, and it makes extremely liberal allowances for the expected growth of traffic. Grain would comprise over 60 per cent of the total and two-thirds of the grain would be of Canadian origin. American export traffic in grain from the territory tributary to the Great Lakes is, in fact, destined practically to disappear in the not distant future. The bulk of the remaining tonnage would consist of fertilizers, sugar, petroleum, coal, and pig iron.

5. *Tax-Payers' Burden.* The annual overhead charges against the waterway, that is, interest and depreciation on the capital investment and maintenance and operation of the route, would amount, when figured on the most conservative basis, to approximately $40,000,000

a year. If the so-called joint costs common to both navigation and power were allocated entirely to power, the charges against navigation would still be as much as \$36,000,000 a year. These overhead costs are not to be covered out of the rates charged to shippers, nor are they to be met by the levy of tolls for the use of the waterway. They are to be paid out of the national treasuries of the two governments—which means that the tax-payers are to contribute about \$3.50 a ton for the benefit of such shippers as would use the route.

Since grain constitutes over 60 per cent of the total traffic, and is fairly typical of the tonnage which might use the route, this commodity may be used to illustrate the fallacy in the argument that the Canadian and American people as a whole would realize great economic advantages from the St. Lawrence project. The overhead charges of \$3.50 a ton are the equivalent of about 11 cents a bushel on wheat and rye, the principal items of grain traffic. The inclusive cost of transporting wheat over the St. Lawrence waterway from Duluth to Montreal would be 5 cents—the actual water rate—plus 11 cents subsidy contributed by tax-payers, making a total of about 16 cents a bushel. Existing wheat rates from Duluth to Montreal average 9 cents a bushel, and from Chicago to New York about 11.3 cents a bushel. The reductions in grain rates that would be effected by enabling ocean carriers to enter the Lakes, or lake boats to move down to Montreal, would be at the most 4 cents a bushel. Thus, in order to effect a reduction of 4 cents a bushel in the cost of moving grain, tax-payers in gen-

eral would have to contribute approximately 11 cents a bushel. The conclusion is therefore inescapable that the proposed 27-foot navigation project cannot be justified on economic grounds. The inclusive costs—to taxpayers and shippers—are much greater than present transportation charges.

It remains to consider certain aspects of the project as they relate to the United States and to Canada separately.

A. THE UNITED STATES

Our analysis has shown that the congestion of railroad traffic immediately after the War which played so important a part in promoting interest in the St. Lawrence waterway project has completely disappeared, and that there is no great likelihood that railway service will prove inadequate during the next decade or so. It has also been demonstrated that the St. Lawrence waterway, because of its seasonal closing and relatively restricted carrying capacity, would not constitute the most satisfactory or most economical means of relieving traffic congestion should it develop in the future.

Similarly, we have found that the contention that the waterway is necessary to control railroad rates is quite without foundation. Not only would it be a relatively ineffective agency for the regulation of railroad rates, but it would constitute an unscientific method as compared with that afforded by regulation through the Interstate Commerce Commission. If, in the interests of the general welfare, it is deemed necessary to reduce freight rates on certain commodities moving between

the Middle West and the Atlantic seaboard, the Commission can reduce them directly. Specially low schedules on certain export traffic have in fact been established, and the policy can be extended if desirable. Such losses in railroad revenues as may be involved could be compensated for by slight rate advances in the rates on other traffic or otherwise at a social cost that would be negligible in comparison with that involved in constructing a waterway as a potential competitor.

In considering the St. Lawrence waterway from the point of view of the United States, a word must be said with reference to the alternative "all-American" route. It has been suggested that the interests of the United States would be best served if a route were constructed from Lake Ontario via New York State waterways to the Hudson. Such a route would, according to the United States engineers who have investigated the problem, involve costs substantially greater than those for the improvement of the St. Lawrence. It follows that the annual charges to be met by the United States tax-payers would be very much larger for the all-American route—not merely because of the greater total cost, but also because the United States would have to bear the entire expense instead of sharing it with Canada. Whether such a route might have naval advantages, is for others to determine.

The United States has another possibility to which attention must be directed. The Canadian government is, as we have seen, constructing a new 27-foot Welland Canal and, as a result, it will shortly be possible to bring

into Lake Ontario, the larger lake boats which draw around 19 feet of water, and even down as far as Ogdensburg on the St. Lawrence River, thus extending cheap lake transportation eastward a distance of as much as 250 miles. This development will supplement milling and trans-shipping facilities at lower lake ports in a desirable way. Oswego has a good lake harbor and already has a connection for export grain with New York City via a branch of the New York State Barge Canal. Both Oswego and Ogdensburg have rail connections with the ports of New York, Boston, and Portland, and through these connections serve the dense consuming area of central and lower New York State and New England. This is of particular importance for feed grains which are used in large quantities in this intensive dairy and poultry region.

B. CANADA

Canada's interest in the proposed 27-foot St. Lawrence development is in certain respects essentially different from that of the United States. The outstanding fact in the Canadian transportation situation is that existing transportation agencies do not have a sufficient volume of traffic. The need is for additional tonnage for the railways rather than for the relief of any congestion, present or potential. Not until the railroad traffic of Canada shows a substantial increase will the Canadian National railways be in a sound financial position, and not until a much denser traffic develops will it be possible for Canadian railroads generally to give the low rates which are desired. For the Canadian government

to incur enormous expenditures for the construction of a waterway designed to divert some of the traffic from the existing railways is clearly unsound national policy; for not only would railroad rates on other traffic have to be increased, but, as we have seen, the Canadian people would find their taxes increased by many millions annually in meeting the capital and operation charges incident to the waterway. Certain shippers would benefit from reductions in transportation rates over a government subsidized water route; but the added taxes and higher rail rates that would result would much more than counterbalance these gains.

Canada has, however, already committed herself to the construction of the New Welland Canal 27 feet in depth, at an estimated cost of $115,000,000 (exclusive of interest during the period of construction). While the authorization of this 27-foot link prior to a decision as to the Great Lakes-St. Lawrence development as a whole was premature, now that the new channel has been virtually completed it has to be reckoned with as an accomplished fact. With the opening of this canal, lake boats will be able to carry Canadian grain and other produce an added distance of 191 miles, from Port Colburn to Kingston at the lower end of Lake Ontario, or 250 miles to Prescott on the St. Lawrence River across from Ogdensburg, N. Y., where a new grain elevator with a capacity of 5,400,000 bushels is now being constructed by the Canadian government at an estimated cost of $4,000,000.

The question may, therefore, be raised whether it would not be desirable for Canada to improve the St. Lawrence to a depth of 22 feet down to Montreal, which would be a sufficient depth to enable the lake boats to move all the way down to that ocean port. Our investigation has shown that the lake carriers are more economical than the ocean boats, and that, even were a deep channel available, ocean boats would find it difficult to compete with lake boats except during the peak season when rates are at the maximum. All the transportation economies between the upper lakes and Montreal that can be effected could be realized by means of a 22-foot channel. Such a depth of channel would involve no substantial improvements of existing inter-connecting lake channels or of lake harbors. While no detailed data are available as to the cost of providing such a channel, it is clear that the expenditure would be only a fraction of that involved in providing a route for ocean-going vessels.

We are not prepared to express judgment upon the desirability of Canada's improving the St. Lawrence to a depth sufficient to permit lake boats to extend their run as far as Montreal. The wisdom of such a development depends in part upon its possible effects upon the quantity of power that could be developed along the river, and also upon its relation to Canadian transportation policy as a whole. A comprehensive national policy should be evolved by the Canadian government—a policy that will embrace considerations of government

finance, railroad rates and earnings, present waterway facilities, power development, and the general economic interests of the country.

In concluding this discussion of the St. Lawrence waterway, it is desirable to point out why waterways generally have come to command widespread popular support. The movement for waterway improvements is based on the conviction that transportation over canals and canalized rivers, like that on the high seas, is very much cheaper than transportation by rail. This conviction is, however, the outgrowth of a wholly fallacious comparison of transportation rates supposed to show that a dollar will carry a ton of traffic many times as far over a canal or river as it will over a railway. The fallacy lies in the fact that the water rates cover only a portion of the costs.

In the early days of inland water transportation in the United States, tolls were charged which were usually sufficient in amount to cover the overhead expenses incident to the construction and the maintenance of the waterway. The total cost of water transportation was then measured by the tolls plus the rates charged by the owners of the boat lines. But, after the development of the railroads, it became necessary to abolish tolls in order for the boat lines to compete with any degree of success against the railroad carriers. This was true not only in the United States, where privately owned and

operated railroads resorted at times to cut-throat competitive methods, but it was equally true in European countries where the railroads were owned by the government and where rates were rigidly controlled. Since the abolition of tolls, the rates charged to the shipper include only the so-called direct costs of moving freight a given distance; and they need be merely sufficiently high to provide a return to the boat owner operating on a toll-free waterway. The enormous overhead costs incident to the construction and the maintenance of the waterway have thus been shifted from the shipper to the tax-payer. These taxes are costs of transportation quite as much as were the tolls which the shippers formerly paid.

The railways, on the other hand, have to make rates sufficient to cover much more than the cost of moving trains over a given route. They must also cover maintenance and upkeep of the railroad tracks and terminals, interest and depreciation on the capital investment, provide revenues for the payment of taxes to the government, and yield sufficient dividends on the stockholders' investment to attract additional capital into the railway business. Thus a citation of rail and water *rates* as evidence of comparative transportation *costs* is a pure fallacy. If a railroad were freed from all interest, dividend, and maintenance charges and from taxes as well, rates to shippers could obviously be greatly reduced. Such a subsidy from the tax-payers would not, however, decrease the inclusive cost of shipping goods; it would only shift the burden of a large part of the cost, from

those who receive the direct benefits of the transportation service, to the tax-payers in general. In connection with waterways this fundamental fact is commonly completely ignored.

Only when all elements of cost, whether contributed by the tax-payers or by the shippers, are included in cost computations will it be possible to determine what transportation projects are economically justifiable and what ones are economically wasteful.

APPENDICES

APPENDIX A

CORRESPONDENCE BETWEEN UNITED STATES AND CANADIAN GOVERNMENTS

I. Note of United States Government to Canadian Government, April 13, 1927

The Honorable
Vincent Massey,
Minister of the Dominion of Canada.

Sir:

For more than one hundred years, the Great Lakes and the St. Lawrence River have furnished a common highway and transportation outlet for the population in the interior of the continent in both the United States and Canada. The waterway has been the subject of several treaties and conventions between the two countries. Its development has been a matter of continuous effort on the part of both countries.

Pursuant to reference made to the International Joint Commission by both governments under authority of the Treaty of January 11, 1909, that Commission made investigation of the feasibility of improving navigational facilities of the St. Lawrence River between Montreal and Lake Ontario so as to transform that section into an ocean shipway. The Commission submitted its report, signed on December 19, 1921, to your Government and to the Government of the United States after taking into consideration the existing characteristics of the waterway and its projected development, as well as the essential economic factors. It earnestly recommended to both governments the making of a treaty for a scheme of shipway improvement of the river between Montreal and Lake Ontario. It suggested, however, that before final decision be made, the engineering features should receive further consideration and study. Delays naturally ensued due to the problems of reconstruction resulting from the war.

On March 14, 1924, the President of the United States appointed the St. Lawrence River Commission under the chair-

manship of the Honorable Herbert Hoover, Secretary of Commerce, to consider the whole project in its economic and national aspects and to express an opinion as to whether the project should be undertaken, and the Government of Canada on May 7, 1924, appointed a national advisory committee under the chairmanship of the Honorable George Perry Graham, Minister of Railways and Canals. Through the arrangements brought about by these committees the two governments by exchange of notes dated February 4 and March 17, 1925, gave instructions to a Joint Board of Engineers designated by them to review and extend the engineering plans as recommended by the International Joint Commission in 1921.

This Joint Engineering Board made an elaborate resurvey of the lake and river systems both as to navigation and power, and filed with each government an exhaustive report upon all its engineering aspects. The representatives of the two countries differed as to a few details, but from the report it clearly appears that the improvement of the waterway for navigation and power purposes is both feasible and advisable.

The St. Lawrence River Commission appointed by the President to advise this Government on the subject recently undertook an examination of all of the economic as well as engineering facts bearing upon the proposed development and has made a complete report covering all aspects. It concluded that the construction of the shipway at proper depths would relieve the interior of the continent, especially agriculture, from the economic handicaps of adverse transportation costs which now operate to the disadvantage of many states and a large part of Canada, would serve the industrial well-being of both countries in the development of their power resources, and would tend largely to the increase of prosperity and the stimulation of industry. The Commission recommended that negotiations should be entered into with your Government in an endeavor to arrive at an agreement as to the speedy development of this waterway.

The Government of the United States adopts the recommendations of the St. Lawrence Commission. It appreciates the advantages which will accrue equally to both countries by the opening of the waterway to ocean shipping. It feels that the necessary increase in railway rates due to the war, and the modern practices respecting the generation and transmission of hydro-electric power have increased the importance and practicability of early development, and believes that the factors which influence its conclusions must have equal application to, and influence upon, the Dominion of Canada.

In view of the action already taken by both governments, it is apprehended that they are in accord in the principle that the project should be undertaken. If this Government's conclusion in this respect be correct, there only remains to be effected an understanding as to the methods and means for its earliest accomplishment. It seems highly appropriate that the development of the common highway for the benefit of both countries should be jointly undertaken.

This Government is prepared to enter into negotiations with a view to the formulation of a convention appropriate to this subject and should be grateful to be informed of the views entertained on this subject by your Government.

Accept, Sir, the renewed assurance of my highest consideration.

FRANK B. KELLOGG.

II. Note of Canadian Government to United States Government, Dated July 12, 1927

The Honorable
The Secretary of State,
Washington, D. C.

Sir:

The Government of Canada has received and considered carefully the note of the Secretary of State of the United States to the Canadian Minister at Washington on April 13th, 1927, on the St. Lawrence waterway.

It shares the appreciation felt by the Government of the United States of the importance of the problem of the development of the St. Lawrence and of the aid in the solution of the engineering aspect of this problem afforded by the reports of the international joint commission and of the joint board of engineers appointed by the two governments in 1925.

The report of the joint board of engineers signed on November 16th, 1926, while unanimous in many respects, indicated differences of opinion on important phases of the development proposed. It is understood that in the appendices to the report, which are in preparation, certain further alternative schemes will be presented which will be of essential value in arriving at a conclusion.

The national advisory committee appointed by the Government of Canada to report on the economic and general aspects of the St. Lawrence waterway question will not be in a position to make a final report until all the findings of the joint engineering board including the appendices are available. Upon receipt of the report of the national advisory committee and upon consideration of the other factors involved, the Government of Canada will be able to determine its policy on the question, and will then have pleasure in discussing further with the Government of the United States at as early a date as possible the whole situation, including the proposals contained in the present note of the Secretary of State.

Accept, Sir, the renewed assurance of my highest consideration.

W. L. MACKENZIE KING.

III. Note of January 31, 1928, from the Canadian Minister to the Secretary of State

Sir:

I have the honour to refer to your note of April 13, 1927, in which, after reviewing the steps taken in recent years by the United States and Canada to enquire into the feasibility of a St. Lawrence ocean shipway, you stated that the Govern-

ment of the United States has accepted the recommendations of the St. Lawrence River Commission, appointed by the President as an advisory body, and was accordingly prepared to enter into negotiations with Canada with a view to formulating a convention for the development of the waterway.

Acknowledgment of this communication was made in a note of July 12, 1927, addressed to the Minister of the United States at Ottawa, in which it was stated that, as the report of the Joint Board of Engineers indicated differences of opinion as to the solution of the engineering difficulties presented by the international section of the waterway, the National Advisory Committee, appointed by His Majesty's Government in Canada to report on the economic and general aspects of the waterway question, would not be in a position to advise the Government until certain alternative schemes under consideration by the Joint Board, and to be included in the appendices to the main report, had been received and duly considered.

The full report of the Board has now been received, and the National Advisory Committee, which met in Ottawa this month, has reported its conclusions to His Majesty's Government in Canada. The National Advisory Committee concurs in the finding of the Joint Board of Engineers that the project is feasible. It recommends, however, that should the work be undertaken, fuller allowance should be made for future requirements by providing, in addition to 30-foot depth for the permanent structures, 27-foot navigation in the reaches rather than the 25-foot navigation proposed by the Joint Board. While the National Advisory Committee regards the project as feasible from an engineering standpoint, and notes the findings of the International Joint Commission in 1921 as to its economic practicability, it considers that the question of its advisability at the present time depends upon the successful solution of a number of financial and economic difficulties, and upon further consideration of certain of the engineering features as to which the two sections of the Joint Board of Engineers are not as yet agreed. I am instructed by the Secretary of State for

External Affairs to inform you that His Majesty's Government in Canada concurs in these conclusions of the National Advisory Committee.

In your note of April 13, it was observed that the St. Lawrence River Commission had reported that the construction of a shipway at proper depth would relieve the interior of the continent, especially agriculture, from the economic handicaps of adverse transportation costs which, it was indicated, now operate to the disadvantage of many States and a large part of Canada. It was added that the Government of the United States appreciated the advantages which would accrue equally to both countries by opening up the waterway to ocean shipping, and that the necessary increase in United States railway rates due to the war, and the desirability of early development of hydro-electric power were factors which must have equal application to, and influence upon, the Dominion of Canada.

In view of the implications as to Canadian conditions contained in these observations, it may be well to indicate certain features of the transportation situation in Canada which have a direct bearing upon the St. Lawrence waterway question.

For many years past the improvement of transportation has been the foremost task of successive governments of Canada. At heavy cost, an extensive programme of railway, waterway and harbour development has been carried out, with the object of linking up all parts of the Dominion and providing adequate outlets for foreign trade. Two great transcontinental railway systems have been built up, largely with State aid, and both western and eastern Canada are now reasonably well served by railways, though increasing settlement and increasing production render it necessary for both systems to continue to spend large sums annually in the provision of branch lines. Western Canada is now looking to the early completion of the Hudson Bay route to Europe. This route, which it is anticipated will be available in about three years, will shorten the haul to Europe from the Canadian West

by a thousand miles and more, and will also be of substantial benefit to shippers from the Western States. Since that work was projected, the completion of the Panama Canal, by the efforts of the United States, has supplied an alternative outlet for much of western Canada through Vancouver and Prince Rupert; and at the present time the Canadian Government is faced with a strong demand for an additional and more direct outlet to the Pacific for the Peace River country. The St. Lawrence route itself has been progressively improved, and has proved of steadily increasing service.

Partly as a result of the existence of competitive alternative outlets, railways rates in Canada are in general lower than in the United States. The rates on grain, which provides fifty-two per cent of the total traffic of western lines, are now below pre-war level. Material reductions have also been made in another bulk movement of importance to both eastern and western Canada; namely, coal. General commodity rates, which were the subject of the same percentage of relative increase in both countries, due to war conditions, have subsequently been reduced in Canada, in certain instances, to a greater extent than in the United States. In recent months a rate on grain has been established from the head of the Lakes to Quebec which approximates the charges incident to the movement by water by the present Great Lakes-St. Lawrence route, a route which, in Canada, has always exercised a restraining influence on railway rates. As the greater part of Canada's railway mileage is now owned and operated by the State, the St. Lawrence proposals, in so far as they may possibly affect the revenues of the railways, present considerations as to which Canada's point of view is necessarily somewhat different from that of the United States.

Canada's interest in the improved navigation of the Great Lakes-St. Lawrence route would be associated largely with the movement of bulk commodities, such as grain, timber and coal. The movement of package freight by water in Canada

is at present of small volume, and Canadian railways, unlike, it is understood, those of the Midwest of the United States, are in a position to handle much more of that traffic than at present is offered.

It is believed that the development of the waterway would prove of advantage to Canadian commerce and industry, not merely in the sections directly tributary to the Great Lakes and St. Lawrence, but in the Maritime sections, which would be afforded more direct access to the great interior markets of the continent. It is, however, apparent that the United States would benefit much more from the enlarged navigation facilities, both in extent of use and in margin of saving. The report of the International Joint Commission in 1921, after a comprehensive review of the economic aspects of the project, presented the following conclusions, to which the National Advisory Committee calls attention:

> "As to the economic practicability of the waterway, the commission finds that, without considering the probability of new traffic created by the opening of a water route to the seaboard, there exists today, between the region economically tributary to the Great Lakes and overseas points as well as between the same region and the Atlantic and Pacific seaboards, a volume of outbound and inbound trade that might reasonably be expected to seek this route sufficient to justify the expense involved in its improvement.
>
> "It finds that, as between the American and Canadian sides of the tributary area, the former contributes very much the larger share of this foreign and coastwise trade, and in all probability will continue to do so for many years to come. The benefits to be derived from the opening of a water route to the sea will, therefore, accrue in much larger measure to American than to Canadian interests, though it is reasonable to assume that eventually the advantages may be more evenly distributed."

The report of the International Joint Commission continues, in a direct reference to comparative transportation conditions:

> "It finds that the existing means of transportation between the tributary area in the United States and the seaboard are altogether inadequate, that the railroads have not kept pace with the needs of the country, but that this does not apply to the Canadian side of the area, where railway development is still in advance of population and production."

It will therefore be observed that the transportation situation in the two countries is not identical as to available facilities, extent of use, or rates, and that the economic handicaps to which you referred in your note of April 13th appear to have more application to United States than to Canadian conditions. In this connection, it may be said that Canadian agriculture is more directly affected by the restrictions on the importation of Canadian farm products which have been imposed by the United States in recent years, with the object, it is understood, of assisting agriculture in those Western States which would share so largely in the benefits of the proposed St. Lawrence Waterway. This situation, and the effects upon the Maritime sections of Canada of United States duties on the products of the fisheries, are among the factors which have contributed to bringing it about that public opinion in Canada has not so clearly crystallized in favour of the waterway project as appears to be the case in the United States.

Reference was made in your note to the early development of hydro-electric power as a factor which must have equal application to and influence upon the Dominion of Canada. The opportunity of developing great quantities of power incidental to navigation is, it is agreed, a special advantage possessed by the St. Lawrence project, and an important consideration in determining its advisability. In this aspect of the project, however, there are again special features in the Canadian situation which it is desirable to make clear. Public opinion in Canada is opposed to the export of hydro-electric power, and is in-

sistent that such power as may be rendered available on the St. Lawrence, whether from the wholly Canadian section, or from the Canadian half of the international section, shall be utilized within the Dominion to stimulate Canadian industry and develop the national resources. With this view the National Advisory Committee expresses itself as in complete accord. The Committee further indicates that, in view of the relatively limited capacity of the Canadian market to absorb the vast blocks of power contemplated by the St. Lawrence proposals, it follows that it is most important, in any arrangement which may be considered, that the development of power on the Canadian side should not exceed the capacity of the Canadian market to absorb it.

The situation presented by the differences of opinion brought out in the report of the Joint Board of Engineers as to the best method of development in the international section of the St. Lawrence has also received consideration by the National Advisory Committee. The Committee considers it greatly in the public interest that a further attempt should be made to reconcile these varying views. Conclusive assurance is necessary as to control of the fluctuations of flow from Lake Ontario, so essential to the interests of the purely national sections of the river and the port of Montreal, and as to the situation of those Canadian communities on the St. Lawrence, which under certain of the present plans might be obliged to live under levees or to rebuild in part. A plan has been presented in the appendices to the report of the Joint Board of Engineers proposing an alternative location of the upper works of the Canadian two-stage plan. It is also considered advisable that opportunity should be afforded for further conference on these alternative proposals between the Canadian section of the Joint Board and engineers representing the Province of Ontario, who have themselves formulated plans dealing with the international section.

The financial phases of the project have been reviewed by the Committee. It is pointed out that for many years Canada

has been engaged in improving the navigation of the St. Lawrence river, both above and below Montreal, and in providing navigation facilities across the Niagara peninsula. At the same time, the United States has been similarly engaged in deepening inter-connecting channels of the Upper Lakes, and in providing suitable works at Sault Ste. Marie. Towards the common object, Canada has made particularly heavy contributions. It has expended over thirty millions on the ship channel which has made possible ocean navigation on a large scale to the port of Montreal, an expenditure by which the proposed St. Lawrence project will directly benefit. The Dominion has spent fifty millions on canals and channel improvements between Montreal and Lake Erie, in which improved navigation United States shipping has had equal use and advantage. To the present, Canada has spent eighty-seven millions on the Welland Ship Canal. In view of these facts and of the very heavy financial burdens imposed by the war, by the railway obligations arising out of the war, and by the necessity, since the war ended, of finding the large sums required for needed public works throughout the Dominion, it is considered that it would not be sound policy to assume heavy public obligations for the St. Lawrence project.

The National Advisory Committee has reached the conclusion that it is possible to work out a method by which provision could be made for the construction of the waterway on terms which would be equitable to both countries and would take adequate account of the special factors in the Canadian situation to which attention has been directed. Several methods have been considered, but the plan which chiefly commends itself to the Committee is, in brief, that Canada should consider providing for the construction of the waterway in the sections wholly Canadian, that is, the Welland Ship Canal and the works in the St. Lawrence below the international boundary, and that the United States should consider undertaking the completion of a 27-foot waterway to the head of the Lakes, in addition to

meeting the entire cost of the development, under joint technical supervision on lines to be agreed upon, of the international section of the St. Lawrence, both for navigation and for power. The construction of the wholly Canadian (Welland and St. Lawrence) sections, and, if the United States should see fit, of the upper lakes works, would, on this plan, be given precedence of the international section, because of the necessity alike of providing for further consideration of the engineering problems involved in the international section and of permitting reasonable absorption of the power developed on the Canadian side.

In support of this view, the following statement is submitted by the Committee, based on expenditures by both countries on the present through waterway, and on the estimated cost of the presently recommended scheme, with 27-foot navigation, a new United States lock at Sault Ste. Marie of the same dimensions as proposed for the St. Lawrence shipway, and the development, on the St. Lawrence, of such power as is incidental to navigation.

CANADA

Present works:		
St. Lawrence ship channel.......	$30,000,000	
St. Lawrence and Welland Canals.	50,000,000	
Lock at Sault Ste. Marie, Ontario.	5,560,000	
		$85,560,000
Proposed works:		
Welland Ship Canal.............	$115,600,000	
Wholly Canadian section, St. Lawrence shipway, 27-ft. navigation and development of 949,300 h. p.	199,670,000	
		315,270,000
Total for Canada.......................		$400,830,000

UNITED STATES

Present works:		
Dredging St. Clair & Detroit rivers	$17,536,000	
Locks at Sault Ste. Marie, Michigan	26,300,000	
		$43,836,000
Proposed works:		
International section St. Lawrence shipway 27-ft. navigation and initial development of 597,600 h. p.	$182,157,000	
To complete development—additional power 1,602,000 h. p.	92,090,000	
Upper lake channels to 27-ft.	65,100,000	
		339,347,000
Total for United States		$383,183,000

In bringing these conclusions of the National Advisory Committee to the attention of the Government of the United States, His Majesty's Government in Canada desires to add that there are phases of the question, particularly as regards the development of power, as to which it is necessary to take account of the special concern of the two provinces of Canada bordering on the waterway. The relation between navigation and power involves certain constitutional difficulties, of which, in accordance with the wishes of the Governments of Ontario and Quebec, the Government of Canada proposes to seek a solution by reference to the courts. With this preliminary difficulty in process of solution, the Government of Canada will be in a position, upon learning from the Government of the United States whether in its view the procedure above outlined affords an acceptable basis of negotiation, to consult with the Provinces of Ontario and Quebec on the aspects of the problem with

which they may be concerned, and thus to facilitate an understanding being reached between all concerned as to the methods and means by which the project could be undertaken.

It is the hope of the Government of Canada that, in any such further consideration of the waterway question, opportunity may be found for reaching a comprehensive settlement of all outstanding problems affecting the Great Lakes and the St. Lawrence, including the preservation of the waters properly belonging to the St. Lawrence watershed, of which the present discussion indicates the paramount importance.

I shall be obliged if you will be good enough to inform me at your convenience, for transmission to His Majesty's Government in Canada, of the views of the Government of the United States on the representations which are outlined above.

I have the honour to be, with the highest consideration, Sir,

Your most obedient, humble servant.

VINCENT MASSEY.

IV. Note of March 12, 1928, from the Secretary of State to the Canadian Minister

Sir:

I have the honor to acknowledge your note of January 31, 1928, in which you inform me of the findings and recommendations of the National Advisory Committee in regard to the proposed waterway improvement.

I note the view of the National Advisory Committee that the question of the advisability of the improvement at the present time depends upon the solution of a number of financial and economic difficulties and upon further consideration of certain of the engineering features and the conclusion of the Committee that it is possible to work out a method by which provision could be made for the construction of the waterway on terms which would be equitable to both countries and would also take adequate account of the factors in the Canadian situation which you have set forth.

The suggestions outlined in your note have received thorough consideration. While the United States is not in complete agreement with the representations made by the Canadian Government as to the relative benefits and ultimate costs to the two countries of the proposed improvement of the St. Lawrence and the division of expense to be borne by each country, it is inclined to regard as an acceptable basis of negotiation a proposal along the general lines suggested in your note: that the prosecution of the improvement of the St. Lawrence waterway be based on the undertaking by the United States of the deepening of the necessary channels through the interconnecting waters of the Great Lakes and the improvement of the international section of the St. Lawrence both for navigation and for power; and the undertaking by Canada of the construction of the waterway in the sections wholly Canadian, that is, the Welland Canal and the works in the St. Lawrence below the international boundary.

Whether the United States expends its share of the cost on the international section and Canada its share on the national sections would seem to be immaterial if, in the negotiations, there is a fair division of expense for a through deep waterway to the Ocean. Of course, in such an arrangement, all sections of the deep waterway should be so constructed as to make them most suitable for a through system of transportation. This is a detail to which I have no doubt your Government will entirely agree. The use of the waterway should be properly safeguarded by treaties between the two countries.

Concerning the value of the route to the sea to the two countries, I have noted the suggestions made in your note of January thirty-first. I might say that, while it may not be very material to the main issue, the United States has the use of the Panama Canal which is of great benefit to it especially on the Pacific, Atlantic and Gulf coasts. It has also the use of the Gulf of Mexico which reaches a considerable way across the Continent on the South and furnishes valuable water trans-

portation for a large portion of the southwestern part of the United States. Both of these waterways exercise a great influence on freight rates. The United States has other harbors on the Atlantic, such as New York served by both railways and the Erie Canal, Philadelphia, Baltimore and Norfolk, which involve a shorter railroad haul from the Great Lakes territory to the Ocean than is enjoyed by Canada. Nevertheless, I feel that the construction of a deep waterway through the St. Lawrence to the Ocean will be of tremendous advantage to most, if not all, of the territory in the northern part of the United States, as well as to the corresponding territory in Canada.

Referring to your suggestions as to the order in which the different works should be undertaken, it would seem that this matter will also have to be the subject of negotiation because the works ought to proceed so that all parts of the navigation system would be completed substantially at the same time and the United States ought to have the advantage of its share of the power of the international section without waiting until Canada may be able to sell her power from these works.

Referring to the balance sheet, which undoubtedly was included in your note to illustrate the principles of the division of costs and the work to be done by each country, I am in general accord with those principles. The amounts and some of the items would have to be considered and discussed in the negotiations. To illustrate: I am not inclined to the view that it is right to include in the balance sheet the costs of the St. Lawrence and old Welland Canals except so far as they may be of use to the deeper system. Those works are understood to be for lighter craft and of little value for the purposes of the works now proposed. These waterways are understood to have served their purpose in economic returns. It would also seem to be necessary to differentiate between the costs that may properly be chargeable to navigation and those to power in general. Those who now or in the future profit by the power should bear their share of the expense. It is understood that the

power development will carry itself. To illustrate: under the suggestions you make, the United States will have no proprietary interest in the power on the national section. It would, therefore, seem that as this development is for the benefit of Canada, your Government should be responsible for that expense, and that such expense should take into account the costs to be borne by the respective interests whether the power is actually installed now or later. The amount, therefore, which power on the national section should contribute to the cost of the improvement should be left open for consideration and subject to determination in the negotiations. All power, of course, developed for joint benefit in the international section should ultimately be paid for as a part of the joint venture. The application of this principle would change the proposed balance sheet considerably. Therefore, if, as you suggest as to this section, the United States is willing to build not only the waterway but the power, it would seem that the United States ought to be permitted to develop its power and use its half, the other half to be used by Canada or not as it should desire.

The United States is agreeable to the proposal that all navigation channels provided in improvements have a minimum depth of 27 feet, the permanent structures having a depth of 30 feet for future expansion. The United States has at present under consideration the deepening of the lake channels to the extent economically justified by the present commerce of the Great Lakes. There is one question that we should like to leave for discussion and that is, whether it would be economical to at once build a new lock and deepen the Soo Canal until such time as the St. Lawrence is nearing completion so that there would be a demand for deeper channels. It is clearly advisable that the large expenditures required for depths in excess of present needs be deferred until the greater depths can be profitably used.

The United States fully recognizes the right of the Dominion of Canada to the ownership and use of the Canadian share

of the power which may be developed in the international section of the waterway as well as to all that developed in the national section, and it recognizes also that the disposition of the power is purely a domestic question. It recognizes further that this share is an inherent attribute of Canadian sovereignty, irrespective of the agency by which the power may be developed.

The United States regards it a fundamental economic principle that the beneficiaries of power developed in the improvement of the International Section of the St. Lawrence should pay ultimately their fair share of the cost of its production, whether the agency constructing these works be a corporation, a state or province, or a national government. It believes that a practicable means can be found for effecting the fulfillment of this principle in the arrangements made for the improvement of the international section of the river for the joint benefit of navigation and power development, and believes that the negotiations entered into in furtherance of the undertaking of the project should have this end in view.

The large expenditures required for the undertaking are a matter of grave concern to the United States as well as to Canada. It is felt that when the United States embarks on the enterprise all expenditures should be on a sound economic basis.

The United States accepts without reservation the principle that the operation of works in the International Section must be such as will control fluctuations of the outflow from Lake Ontario in such manner as to safeguard all interests on the purely Canadian sections of the river, including especially the Port of Montreal. It regards as acceptable the proposal that the design and operation of works in the International Section of the river be under joint technical control and assumes that the design of all works on the waterway will comply in general with the plans agreed upon by the Joint Engineering Board as embodying the best principles.

The United States is fully in accord with the view that the advisability of undertaking the improvement at the present

time depends on the solution of the financial and economic problems involved. It shares the hope expressed that a solution will be found which will fully safeguard the interests of the two countries and will afford an equitable basis for a division of the cost. It is confident that when these economic principles are determined, the solution of the engineering problems required for their fulfillment will be speedily realized.

I have the honor to suggest, therefore, that the two countries proceed with the appointment of commissioners to discuss jointly the problems presented in your note, and those which I have presented herein with a view to the formulation of a convention appropriate to the subject.

The Government of the United States will be glad to have this discussion extended to the further consideration of any outstanding problems affecting the Great Lakes and the St. Lawrence as suggested in your note.

Accept, Sir, the renewed assurance of my highest consideration.

FRANK B. KELLOGG.

V. Note of April 5, 1928, from Mr. Laurent Beaudry, First Secretary of the Canadian Legation, to the Secretary of State

Sir:

I have the honour to refer to your note of March 12, 1928, on the St. Lawrence Waterway project.

The Secretary of State for External Affairs has noted that while the United States is not in complete agreement with the representations contained in my note Number 30 of January 31st, 1928, as to the relative benefits and ultimate costs to the two countries of the proposed improvement and the division of expenses to be borne by each country, it is inclined to regard as an acceptable basis of negotiation the suggestions of the National Advisory Committee summarized in my note as to the division between Canada and the United States of the tasks involved in the completion of the Deep St. Lawrence Waterway.

The Secretary of State for External Affairs has also noted that the United States agrees that a channel of twenty-seven feet minimum depth would be advisable, accepts the principle that the works in the international section must be so operated as to control fluctuations of the outflow from Lake Ontario in such manner as to safeguard all interests on the purely Canadian sections, including the Port of Montreal, and agrees that the design and operation of the works in the international section should be under joint technical control. It is noted also that the United States would be prepared to have the discussion extended to the consideration of any outstanding problems affecting the Great Lakes and the St. Lawrence watershed, as suggested in my previous note.

In your note under reference you raise some question as to the relative advantage of the waterway to each country and as to the validity of some of the items included on the Canadian side of the balance sheet presented for illustrative purposes by the National Advisory Committee, and refer also to the problems involved in the allocation of costs as between navigation and power. At the present stage it does not appear necessary to discuss these points in detail.

It is further noted that you do not favour the recommendation of the National Advisory Committee, which was an integral feature of its plan and of the division of tasks which it proposed, that the works on the national section should be given priority over the works on the international section in order to permit an agreed solution of the engineering difficulties in this area, and to ensure reasonable absorption of the power developed on the Canadian side. In view of the fact that the market for hydro-electric power in Canada, though large and rapidly expanding, has definite limitations, and that export of power is considered contrary to public policy, it is an essential factor in any plan economically feasible from the Canadian standpoint that, whether through the priority procedure set out by the National Advisory Committee or by

some alternative method, the development of power to be utilized in Canada should not outrun the capacity of the Canadian market to absorb and thus to meet the proportion of the costs of the waterway fairly chargeable to power.

The National Advisory Committee laid emphasis on another phase of the situation—the necessity of reconciling the divergent views of the two sections of the Joint Board of Engineers as to the best method of development in the international section of the St. Lawrence. Definite and agreed engineering proposals for the development of this section would appear to be a necessary preliminary to any computation of costs or decision as to the order of construction or division of tasks. His Majesty's Government in Canada has previously referred to the view of the National Advisory Committee, which it shares, that a conference should be held between the Canadian section of the Joint Board and engineers representing the Province of Ontario. It would appear advisable that such a conference should be followed by reconsideration of the engineering problems in the international section by the whole Joint Board.

Reference was made in my previous note to certain constitutional questions affecting the Canadian situation, and to the intention of His Majesty's Government in Canada, in accordance with the wishes of the Governments of Ontario and Quebec, to seek a solution by reference to the Courts. Steps have since been taken to this end, and it is anticipated that the reference will come before the Supreme Court of Canada at an early date.

It was further indicated in my previous note that, with the constitutional question in process of solution, His Majesty's Government in Canada would be in a position, upon learning whether the Government of the United States considered that the procedure suggested by the National Advisory Committee formed an acceptable basis of negotiation, to consult with the Provinces of Ontario and Quebec upon the aspects of the problem with which they may be concerned. While the acceptance by the United States of this basis of negotiation is

attended with important qualifications, yet the position of the Government of the United States has been made sufficiently clear and definite to permit the Government of Canada to take the necessary step thus contemplated and discuss with the provinces the aspects in question. Following this consultation, His Majesty's Government in Canada will be in a position to inform the Government of the United States further of its views on the proposals contained in your note of March 12th.

I have the honour to be, with the highest consideration, Sir,

Your most obedient, humble servant,

LAURENT BEAUDRY.

(For the Minister).

VI. Note of April 7, 1928, from the Secretary of State to the Canadian Minister

Sir:

I have the honor to receive your note of April 5, 1928, with reference to the negotiations between the Canadian Government and the United States looking to the construction of the deep St. Lawrence waterway. I note your suggestion that the position of the United States has been made sufficiently clear and definite to permit the Government of Canada to take the necessary steps contemplated and to discuss with the provinces of Ontario and Quebec the aspects in question. I entirely agree with you that there is no reason why at this time the Government of Canada should not take up such discussion with the provinces.

I note also that His Majesty's Government in Canada suggests that it would be advisable that definite and agreed engineering proposals for the development of the International Section would appear to be necessary preliminary to any computation of costs or decision as to the order of construction or division of tasks and that a conference should be held between the Canadian section of the Joint Board and engineers representing the province of Ontario. Further that it would be ad-

visable that such a conference should be followed by reconsideration of the engineering problems in the International Section by the whole Joint Board. Of course, the Government of the United States fully realizes the desirability of the Canadian Government's consultation with the provinces and with the Canadian section of the Joint Board of Engineers. The United States section of the Joint Board will be prepared at any time to take up with the full Board and discuss and reconsider engineering problems connected with the construction of the International Section. I have the honor to suggest, however, that it would seem as though the entire subject of treaty negotiation need not be postponed until the termination of these discussions and of the reconsideration by the Joint Board of Engineers and that it might be desirable for the negotiations to go on concurrently with the examination of such engineers as their advice and assistance would be necessary. The United States will be prepared to coöperate to the fullest extent with the Canadian Government at any time for the purpose of accomplishing the improvement contemplated.

Accept, Sir, the renewed assurance of my highest consideration.

FRANK B. KELLOGG.

APPENDIX B

I. Schedule of Sailings from New York for North European Ports, June, 1928 [a]

Day	Passenger-Cargo					Cargo				
	Name	Nationality	Gross Tons	Draft (Feet)	To	Name	Nationality	Gross Tons	Draft (Feet and inches)	To
1	Carinthia	British	20,277	32	London	Francisco	British	6,272	27	Aberdeen, Hull
1						Chifuku Maru	Japanese	5,857	21 ..	Hamburg
2	Arabic	British	16,786	31	Antwerp	Korsholm	Swedish	2,647	21	Helsingfors, Stockholm
2	America	United States	21,329	34	Bremen	London Exchange	British	6,640	29 .	London
2	Frederick VIII	Danish	11,850	28	Christiansand, Oslo Copenhagen	Hoxie	United States	4,623	24	Manchester
2	California	British	16,792	29	Glasgow					
2	Stockholm	Swedish	12,765	31	Gothenburg					
2	New York	German	20,000	33	Hamburg					
2	Paris	French	36,558	32	Plymouth, Havre					
2	Franconia	British	20,000	31	Liverpool					
2	Cedric	British	21,073	37	Liverpool					
2	Minnetonka	United States	21,998	36	London					
2	Rotterdam	Dutch	24,149	33	Plymouth, Rotterdam					
2	Majestic	British	36,551	38	Southampton					
5	Stavengerfjord	Norwegian	13,156	26	Christiansand Bergen (Norway) Stavengerfjord	Eastern Dawn	United States	5,842	27	Antwerp
6	President Harding	United States	14,127	30	Bremen	Patagonier	Belgian	5,172	25 3	Antwerp
6	De Grasse	French	17,000	28	Havre	East Side	United States	4,750	24	Belfast, Dublin, Glasgow
6	Berengaria	British	52,226	39	Southampton	Sarcoxie	United States	5,116	25	Dunkirk, Havre
7	Belgenland	Belgian	27,132	36	Antwerp	Naumburg	German	5,872	25 3	Bremen, Hamburg
7	Karlsruhe	German	10,826	30	Bremen					
7						American Trader	United States	7,430	27 0¼	London
7						Anaconda	United States	6,093	27 ..	Rotterdam

8	Caronia	British	19,782	33	London, Havre						
8	Republic	United States	17,910	33	Bremen						
9	Columbus	German	32,500	32	Bremen	Caucasier	Belgian	5,852	26	..	
9	Cameronia	British	16,365	29	Glasgow	Schenectady	United States	5,114	24	5	Copenhagen, Helsingfors
9	Deutschland	German	21,000	33	Hamburg	Boston City	British	2,870	23	10	
9	Gripsholm	Swedish	18,017	29	Gothenburg						
9	Ile de France	French	43,548	32	Plymouth, Havre						
9	Adriatic	British	24,563	37	Liverpool						
9						Caledonian	British	4,998	26	..	Liverpool, Manchester
9	Laconia	British	19,695	32	Liverpool						
9	Minnekahda	United States	17,220	33	London						
9	Volendam	Dutch	15,434	32	Plymouth, Rotterdam						
9	Olympic	British	46,439	35	Southampton						
9	Mauretania	British	30,704	36	Southampton						
12						Saco	United States	5,106	24	5	Antwerp
12						Vechtdyk	Dutch	6,869	28	..	Rotterdam
13	President Roosevelt	United States	14,127	30	Bremen	Carlier	Belgian	7,217	28	..	Antwerp
13						Anacortes	United States	4,889	23	8	Belfast, Cork, Glasgow, Dublin
13						Pipestone County	United States	5,102	24	5	Dunkirk, Havre
14	Muenchen	German	15,000	28	Bremen	Singapore Maru	Japanese	5,859	27	..	Hamburg
14	Thuringia	German	11,000	29	Hamburg	Ambridge	United States	6,631	27	..	Rotterdam
14						American Shipper	United States	7,430	31	..	London
15	Tuscania	British	16,991	29	London, Havre	Marengo	British	6,302	28	1	Antwerp, Newcastle, Hull
16	Pennland	Belgian	16,500	28	Antwerp	Norefjord	Norwegian	3,082	23	..	Bergen, Oslo, Christiansand
16	United States	Danish	9,993	27	Christiansand, Oslo Copenhagen						
16	Estonia	Danish	6,343	24	Copenhagen	Kolsnaren	Swedish	2,465	21	..	Helsingfors, Stockholm
16	Caledonia	British	17,046	29	Glasgow	London Mariner	British	7,896	30	2	London
16	Resolute	German	19,692	29	Hamburg	Kerhonkson	United States	4,768	24	..	Manchester
16	Rochambeau	French	13,391	29	Havre						
16	France	French	23,769	32	Plymouth, Havre						
16	Samaria	British	19,597	32	Liverpool						
16	Celtic	British	21,179	37	Liverpool						
16	Minnewaska	United States	21,716	36	London						
16	Veendam	Dutch	15,450	32	Plymouth, Rotterdam						

[a] List of vessels and their ports of destination compiled from *Shipping Digest*. Data on tonnage, nationality and draft obtained from *Lloyd's Register of Shipping* and from the records of the Bureau of Research, United States Shipping Board.

SCHEDULE OF SAILINGS FROM NEW YORK—(*Cont'd*)

Day	Passenger-Cargo					Cargo				
	Name	Nationality	Gross Tons	Draft (Feet)	To	Name	Nationality	Gross Tons	Draft (Feet and inches)	To
16	Homeric	British	34,351	35	Southampton					
16	Leviathan	United States	59,951	40	Southampton					
18	Cleveland	German	15,746	34	Hamburg					
19	George Washington	United States	23,788	34	Bremen	Chicago City	British	2,324	22 8	
						West Eldara	United States	5,607	24 $2\frac{1}{4}$	Antwerp
20	Stuttgart	German	14,500	28	Bremen	Elzasier	Belgian	5,120	25 ..	Antwerp
20	Aquitania	British	45,647	36	Southampton	Coelleda	United States	4,986	25 ..	Belfast, Dublin, Glasgow
20						Collamer	United States	5,112	25 ..	Dunkirk, Havre
20						Carlsholm	Swedish	3,422	23 .	Gottenburg, Norrkoeping, Stockholm
21						City of Alton	United States	5,590	24 $5\frac{3}{16}$	Rotterdam
21						Bird City	United States	4,983	24 ..	Copenhagen, Helsingfors
21						American Farmer	United States	7,430	27 $0\frac{1}{4}$	London
22	Carmania	British	19,566	33	London	Andalusia	Italian	4,499	24 .	London
23	Minnesota	British	11,667	30	London					
23	Lapland	British	18,566	33	Antwerp	Hellig Olav	Danish	9,939	27	Copenhagen, Oslo, Christiansand
23	Bergensfjord	Norwegian	11,012	26	Bergen; Oslo	Malaren	Swedish	2,699	21 2	Helsingfors, Stockholm
23	Berlin	German	15,500	29	Bremen					
23	Transylvania	British	16,700	29	Glasgow					
23	Hamburg	German	21,133	32	Hamburg					
23	Paris	French	36,558	32	Havre, Plymouth					
23	Drottingholm	Swedish	11,165	32	Gothenburg					
23	Scythia	British	19,761	30	Liverpool					
23	New Amsterdam	Dutch		35	Plymouth, Rotterdam					
23	Majestic	British	56,551	38	Southampton					
25	Baltic	British	23,884	37	Liverpool	Suevier	Belgian	4,933	25 2	Antwerp
26	Albert Ballin	German	21,000	33	Hamburg					
26	Yorck	German	8,976	30	Bremen	Tirpitz	German	7,970	26 $9\frac{1}{2}$	Hamburg

27	Berengaria	British	52,226	39	Southampton	Bellhaven	United States	9,786	27	..	Dublin, Glasgow, Belfast
27						Schodack	United States	5,041	24	..	Havre, Dunkirk
28	Dresden	German	14,690	29	Bremen	Victoria Maru	Japanese	5,873	27	..	Hamburg
28						American Merchant	United States	7,430	27	0¼	London
29	Olympic	British	46,439	35	Southampton	Idaho	British	4,887	28	..	Aberdeen
30	Mauretania	British	30,704	36	Southampton						
30	Arabic	British	16,786	31	Antwerp	London Corporation	British	6,629	29	4	London
30	America	United States	21,329	34	Bremen	Mahronda	British	7,880	27	..	London
30	Oscar II	Danish	10,012	27	Copenhagen, Oslo	Bannack	United States	4,844	24	..	Manchester
30	Cameronia	British	16,365	29	Glasgow	Wytheville	United States	6,093	27	0¼	Rotterdam
30	Ile de France	French	43,548	32	Havre, Plymouth						
30	Suffren	French	12,350	28	Havre						
						Sparreholm	Swedish	2,978	22	..	Stockholm, Gothenburg
30	Cedric	British	21,073	37	Liverpool						
30	Franconia	British	20,000	31	Liverpool						
30	Minnetonka	United States	21,998	36	London						
30	Rotterdam	Dutch	24,149	33	Rotterdam						
30	Sierra Cordoba	German	11,469	30	Bremen						

II. Schedule of Sailings from Boston and Baltimore for North European Ports, June, 1928 [a]

A. FOREIGN VESSELS

From Last United States Port (Day)	Name	Nationality	Gross Tonnage	Draft (In Feet and Inches)	From Baltimore (Day)	From Boston (Day)	From New York (Day)	To
2	Davisian	British	6,433	29 ..	2	b	b	Manchester
3	California	British	16,792	29 ..		3	2	Glasgow
5	Nortonian	British	6,367	29 ..	5	May 29	c	London
5	Anchoria	British	6,112	26 ..		5		Avonmouth, London
9	Caledonian	British	4,998	26 ..		2	9	Liverpool, Manchester
9	Gerwin	German	4,169	24 9	9			Bremen, Hamburg
9	Republic	United States	7,910	33 ..		9	8	Bremen
13	Idarwald	German	5,033	26 3	13	b	b	Hamburg
13	Hamburg	German	4,486	24 6	13	b	b	Bremen
16	Dania	Danish	3,447	23 6½	16	2		Copenhagen, Oslo
17	Caledonia	British	17,046	29 ..		17	16	Glasgow
19	Maryland	French	5,446	24 2	19	d	d	Dunkirk, Havre
20	Carlsholm	Swedish	3,422	23 2	6		20	Gothenburg, Stockhlom
20	Masirah	British	6,836	28 ..	16	20		London
20	Missouri	British	4,697	26 9	20	14		London
21	Beemsterdyk	Dutch	6,869	30 2	21	8		Rotterdam
23	Hannover	German	7,458	29 ..	23	b	b	Bremen, Hamburg
25	Manchester	British	4,076	26 ..	25	c	c	Manchester
27	Iserlohn	German	3,704	24 4	27	b	b	Bremen, Hamburg
29	Idaho	British	4,887	28 ..		19	29	Aberdeen, Hull
29	Novian	British	6,368	29 ..	29	23		Liverpool, Manchester
29	Arkansas	Danish	3,651	23 ..		29	d	Oslo
29	Norwegian	British	6,357	29 ..		29	c	London
30	Mahronda	British	7,880	27	27		30	London

B. UNITED STATES LINES

2	West Harcuvar		5,696	24	..		2	d	Bremen, Hamburg
2	Ambridge		6,631	27	..	2		14	Rotterdam
6	Chickasaw		4,948	24	5	(May) 29	6		London, Hull
8	West Eldara		5,607	24	2	8		19	Antwerp
8	Tomalva		5,104	24	5		8	d	Antwerp
9	Bellflower		6,085	27	..	(May) 31	9		Liverpool, Manchester
9	V. Emmanuele III.		4,855	23	9	9	19	c	Bremen
13	Anacortes		4,889	23	8	6		13	Glasgow, Belfast, Dublin, Cork
13	Pipestone County		5,102	24	5		2	13	Havre
16	Kerhonkson		4,768	23	8	7		16	Manchester
16	Lorain		6,213	27	..		16	d	Bremen, Hamburg
20	Lehigh		4,983	24	5	12	20		London, Dundee
20	Coelleda		4,986	25	..	13		20	Glasgow, Belfast, Dublin, Cork
20	Coillamer		5,102	25	..	12		20	Havre, Dunkirk
20	West Campgaw		5,565	24	1	20		c	Bremen
21	City of Alton		5,590	24	5	13		21	Rotterdam
22	Sacandaga		4,967	24	5	22		d	Antwerp
22	Ala		5,976	25	2	22		(July) 3	Antwerp
23	Kearny		6,096	27	..	14	23		Liverpool, Manchester
26	Quaker City		4,961	24	5	26	(July) 4		London, Hull
27	Bellhaven		9,786	27	..	21		27	Glasgow, Belfast, Dublin, Cork
27	Schodack		5,041	24	5	22		27	Havre, Dunkirk
30	Bannack		4,844	23	8	21		30	Manchester
30	Wytheville		6,098	27	..		18	30	Rotterdam
(July) 3	Cold Harbor		5,010	25	..	27		(July) 3	Glasgow, Belfast, Dublin, Cork
5	Innoko		6,093	27	..		26	(July) 5	Rotterdam
7	Winoma County		6,049	27	..	28	(July) 7		Manchester
12	Western Ally		5,834	25	6	30		(July) 12	Rotterdam
Friom Last									

[a] List of vessels and their ports of destination compiled from *Shipping Digest.* Data on tonnage, nationality and draft, obtained from *Lloyd's Register of Shipping* and from the records of the Bureau of Research, United States Shipping Board. Certain of the boats sail from ports other than Boston and/or New York:
[b] Sail from Philadelphia and Hampton Roads.
[c] Sail from Hampton Roads.
[d] Sail from Philadelphia.

III. ALL VESSELS ARRIVING AT NEW YORK FROM BRITISH AND CHANNEL PORTS, DECEMBER, 1927 [a]

Day	Passenger-Cargo					Cargo				
	Name	Nationality	Gross Tons	Draft (Feet)	From	Name	Nationality	Gross Tons	Draft (Feet and inches)	From
1	Volendam	Dutch	15,434	32	Rotterdam	Luossa	Swedish	5,580	25 3	Hamburg
1						City of Alton	United States	5,590	24 5 3/16	Rotterdam
2	Aquitania	British	45,647	36	Southampton	Clairton	United States	6,080	27 0¼	Manchester, Belfast
2						Natirar	United States	4,659	24	Finland
2	Muenchen	German	15,000	28	Bremen	Cape Town Maru	Japanese	5,827	27 1	Hamburg
3	Suffren	French	12,350	28	Havre	Francisco	British	6,272	27 .	Aberdeen, Hull
						Fernbank	Norwegian	4,333	25 .	Sweden
3						Tomalva	United States	5,104	24 5 5/16	Antwerp
3						Vincent	United States	6,210	27 0¼	Havre
										Dunkirk
4						Fabian	British	3,059	23 5	Manchester
4						Carlier	Belgian		28	Antwerp
4						Rowena	Norwegian	3,779	22	Hamburg
4						West Eldara	United States	5,607	24 2¼	Antwerp
5	Baltic	British	23,884	37	Liverpool					
5	Berlin	German	15,500	29	Bremen, Bremerhaven					
5	Polonia	Danish		29	Danzig, Copenhagen					
6	Ascania	British	14,000	31	London	American Banker	United States	7,430	27	London
6	Minnekahda	United States	17,220	33	London	Carlsholm	Swedish	3,422	23	Finland
6	Andania	British	14,000	31	Liverpool					
6	Transylvania	British	16,700	29	Glasgow					
6	Westphalia	German	11,600	29	Hamburg					
7	Olympic	British	46,439	35	London					
8	Veendam	Dutch	15,450	32	Rotterdam					
9	Gripsholm	Swedish	18,017	29	Sweden	New York City	British	2,736	23 8	Bristol
10	Westerdijk	Dutch	8,261	32	Rotterdam	Challenger	United States	7,590	30 6	Avonmouth
10	De Grasse	French	17,000	28	Havre	City of Flint	United States	4,963	24 4¼	Hull
11						Waukegan	United States	6,209	27 0¼	Havre

13	Cedric	British	21,073	37	Liverpool	Samland	Belgian	9,748	28	11	Antwerp
13	Belgenland	British	27,132	36	Antwerp	Ala	United States	5,976	25	2	Antwerp
13	Albert Ballin	German	21,000	33	Hamburg						
14	Alaunia	British	14,000	32	London	London Mariner	British	7,896	30	2	London
					Bordeaux cargo						
					Southampton cargo						
14	Scythia	British	20,000	30	Liverpool	Suevier	Belgian	4,983	25	2	Antwerp
14	Reliance	German	20,000	28	Hamburg						
14	President Roosevelt	United States	14,127	30	Bremen						
					Bremerhaven						
14	Paris	French	36,558	32	Havre						
15	Berengaria	British	52,226	29	Southampton	American Merchant	United States	7,430	27	0¼	London
15	Stuttgart	German	14,500	28	Bremen, Bremerhaven	Nordvard	Norwegian	4,111	24	..	Hamburg
						Hjelmaren	Swedish	2,467	21	..	Finland
16	Stavangerfjord	Norwegian	13,156	26	Norway	Suveric	British	4,030	26	10	Glasgow
17	Franconia	British	20,000	31	Liverpool	Korsholm	Swedish	2,647	21	..	Sweden
17	Estonia	Danish	6,345	24	Danzig, Copenhagen						Manchester
18	Minnewaska	British	21,716	36	London	Kearny	United States	6,096	27	0¼	Belfast
18						Highland Prince	British	4,798	24	..	Dundee
											Newcastle
18	Columbus	German	32,500	32	Bremen, Bremerhaven						
18						American Farmer	United States	7,430	27	0¼	London
						Gaasterdijk	Dutch	8,373	30	..	
19	New York	German	20,000	33	Hamburg	Kabinga	British	4,657	26	..	Leith
19						Marengo		6,302	28	1	Hull
											Newcastle
											Antwerp
20	Ausonia	British	14,000	31	Southampton	Innoko	United States	6,093	27	0¼	Rotterdam
20	Minnesota	British	11,667	30	London	Californie	French	5,158	27	..	Dunkirk
											Havre
20	Thuringia	German	11,600	29	Hamburg	Dakotian	British	6,426	29	2	Bremen
20	Calgaria	British	16,000	33	Liverpool						
20	Letitia	British	13,500	28	Glasgow						
21	Leviathan	United States	59,951	40	Southampton	Wytheville	United States	6,098	27	0¼	Rotterdam
22	Winifredian	British	10,418	31	Antwerp	Bolivier	Belgian	4,953	25	2	Antwerp
23	President Harding	United States	14,127	30	Bremen	Chicago City	British	2,324	22	8	Bristol

VESSELS ARRIVING AT NEW YORK—(*Cont'd*)

Day	Passenger-Cargo					Cargo				
	Name	Nationality	Gross Tons	Draft (Feet)	From	Name	Nationality	Gross Tons	Draft (Feet and inches)	From
23	Rochambeau	French	13,391	29	Havre	Mercier	Belgian	7,816	27 .	Antwerp
23						Talisman	Norwegian	4,765	25 6	Antwerp
24	Lancastria	British	16,500	29	Southampton	Ashburton			25	Liverpool, Manchester
24						Yokohama	Danish	3,213	22	Sweden
24	Ryndam	Dutch	12,531	33	Rotterdam	Minnequa	United States	5,165	34	Finland
27	Deutschland	German	21,000	33	Hamburg					
26	Minnetonka	British	21,998	36	London	American Trader	United States	7,430	27 0¼	London
26	Albertic	British	19,000	31	Liverpool	City of Durban	British	4,499	25 7	Glasgow
26						Kifuki Maru	Japanese	5,822	27 1	Hamburg
27	Mauretania	British	30,704	36	Southampton	City of Canberra	British	7,070	27	Liverpool
27	Aurania	British		31	Liverpool	Bellflower	United States	6,085	27 0¼	Manchester
										Belfast
27	Pennland	British	16,500	28	Antwerp	Baron Cochrane	British	3,385	21 4	Hull
27	Oscar II	Danish	10,012	27	Denmark	Independence Hall	United States	5,050	24	Havre
										Dunkirk
27						Westerner	United States	5,663	24 1	Antwerp
27						Sarcoxie	United States	5,116	25 ..	Havre
										Dunkirk
27						Hatteras	United States	4,571	23 10	Dublin
										Cork
										Londonderry
28						Boston City	British	2,870	23 10	Bristol
28						Westernport	United States	5,665	24 2	Rotterdam
29						London Corporation	British	6,629	29 4	London
30						Tarantia	British	4,939	24 ..	Glasgow
30						Patogonier	Belgian	5,172	25 3	Antwerp
30						Clara Camus	Italian	7,030	25 6	Rotterdam
31	Majestic	British	56,551	38	Southampton					

[a] List of vessels compiled from New York *Journal of Commerce*. Data on tonnage, nationality, and draft obtained from *Lloyd's Register of Shipping* and from the records of the Bureau of Research, United States Shipping Board.

IV. VESSELS CHARTERED IN UNITED STATES TRADE BETWEEN NORTH ATLANTIC AND EUROPEAN PORTS, APRIL TO SEPTEMBER, 1928 [a]

(Funch Edye Report)

Trade	Vessel Particulars: Name	Nationality	Year Built	Gross Tonnage	Draft (In Feet and Inches)	Cargo	Form of Charter [b]	Date of Loading
1. UNITED KINGDOM								
Portland, Me.. to United Kingdom	Denmark Maru	Japanese	1920	5,870	27 ..	Grain		April
New York " " "	Irland	Danish	1927	3,172	20 6½			April
" " " " "	Mindoro	British	1914	4,532	24 1½		Time	April
" " " " "	Hendon Hall	British	1920	5,627	26 3			April
" " " " "	Anna Sofie	Norwegian	1919	3,100	21 8		Time	May
" " " " "	Yokohama	Danish	1920	3,213	22 ..		Time	May
" " " " "	Soesterberg	Dutch	1927	1,891	17 8¾	Cotton		May
" " " " "	Charlotte Cords	German	1923	1,779	17 11		Time	July/Aug.
" " " " "	Levenbridge	British	1928	4,342	23 11¾	Raw sugar		August
" " " " "	Etna	Swedish	1918	2,619	20 10	" "		August
Portland, Me. " " "	Vinemoor	British	1924	4,359	25 ..	Wheat		September

VESSELS CHARTERED IN UNITED STATES TRADE—(*Cont'd*)

Trade	Vessel Particulars					Cargo	Form of Charter	Date of Loading
	Name	Nationality	Date Built	Gross Tonnage	Draft (In Feet and Inches)			
2. NORTH EUROPEAN								
New York " Leningrad	Truth	Norwegian	1910	3,655	21			April
Baltimore " Rotterdam	Goldbek	German	1923	1,438	17 ..	Cotton		Mar./Apr.
New York " Bremen	Ulla	Swedish	1920	1,847	18 .	"		April
Baltimore " Hamburg	Romera	British	1909	4,962	24 ..			April
Boston " Danzig	Aggersund	Danish	1892	2,940	21 .	Scrap iron		April
New York " Bremen	Yselhaven	Dutch	1921	4,802	25 2	Cotton		April
North Atlantic " Scandinavian port	Bedeburn	British	1916	3,132	23			April
New York " Leningrad	Waalhaven	Dutch	1916	3,551	22 .	Agriculturals, general		April
Baltimore " Rotterdam	Dalmazia	Italian	1920	6,468	29 .	Asphalt		May/June
Boston " Danzig	Truth	Norwegian	1910	3,655	21	Scrap iron		May
Providence " Danzig	Hanna Cords	German	1926	1,891	17 10	" "		May
Baltimore " Brake	August	Norwegian	1911	5,254	24 8	Asphalt		May
New England " Danzig	Visna	Norwegian	1914	1,845	17 5	Scrap iron		July
Boston " Danzig	Copenhagen	Danish	1919	2,354	22 1½	" "		July
Boston " Danzig	Cosmona	Italian	1901	5,205	27 ..	" "		July
" " "	Venus	German	1892	2,581	20 11	" "		August
New York " Hamburg	Aaro	Danish	1925	1,426	16 6			Sept./Oct
" " " "	Hazelpark	British	1922	2,405	19 5		Time	September
Baltimore " "	A steamer	...	....	....	..	Asphalt		April
" " Rotterdam	A steamer	....	....	6,400	..	Asphalt		May

3. SOUTH EUROPEAN AND MEDITERRANEAN									
Baltimore to Spain	Etna	Swedish	1918	2,619	20	10	Asphalt		April
" "	Falterona	Italian	1901	3,950	24	..	"		April
Portland " Naples	Yeifuki Maru	Japanese	1918	5,861	27	1	Grain		Mar./Apr.
New York " Black Sea ports	Ferento	Italian	1924	6,232	26	..	Agriculturals, general		April
" " " Mediterranean	— Maru	Japanese					35,000 quarters grain		April
" " " Black Sea	Numidia	Italian	1913	5,339	24	..	Agriculturals, general		May
" " " Spain	Dicto	Norwegian	1917	3,778	22	7		Time	June
" " " "	Hertha	Norwegian	1917	1,365	16	1			September
" " " Black Sea	Augstvard	Norwegian	1925	3,677	23	..	Agriculturals		August
Hampton Roads to West Coast Italy	Impero	Italian	1900	6,749	27	0	Coal		May
" " " " " "	Marigola	Italian	1906	5,996	26	10	"		May
" " " " " "	Monarca	Italian	1897	7,430	28	4	"		July
" " " " " "	Dalmazia	Italian	1920	6,468	28	2	"		June
" " " Alexandria	Antar	British	1920	6,503	28	4	"		July
Baltimore " West Italy	Aequitas	Italian	1916	5,335	24	0	"		June
Hampton Roads " " "	Dignitas	Italian	1918	5,376	24	2	"		July/Aug.
" " " " "	Maria Enrica	Italian	1905	7,668	26	0	"		August
" " " " "	Nordico	Italian	1903	7,261	29	5	"		Aug./Sept.
" " " " "	Monarca	Italian	1897	7,430	28	4	"		September
" " " " "	Pratomagno	Italian	1900	6,963	27	9	"		Sept./Oct.
4. TRANS-ATLANTIC (Ports of loading and discharge not given)									
	P. N. Damm	Danish	1924	2,281	18	11	Sugar		April
	Wilson	British	1916	3,221	21	..	Asphalt		Apr./May
New York " European	A steamer							Time	
North Atlantic " United Kingdom	Crandon	British	1914	3,108	20	6		Time	June
	Arlington Court	British	1924	4,915	23	8½		Time	August
	Nyanza	British	1928	4,980	24	5		Time	August
	Hamdale	British	1914	4,782	25	3			August
	Malmen	Swedish	1919	4,449	22	.			August
	Heathfield	British	1919	5,263	24	..			September

[a] Data on gross tonnage, draft and age of vessels obtained from *Lloyd's Register of Shipping* and from the records of the Bureau of Research, United State Shipping Board.
[b] Unless specified as a time charter, the contract is on a trip basis.

APPENDIX C

APPRAISAL OF TRAFFIC ANALYSES MADE BY OTHERS

As many as four attempts have been made by others to estimate the traffic potentialities of the St. Lawrence route. The methods used in these studies will be briefly described and analyzed.

I. The Findings of the International Joint Commission

The first effort to grapple with the traffic problem was that made by the International Joint Commission, which in 1920 held extensive hearings as an aid in preparing the report requested from it by Congress. As was perhaps inevitable, those interested in the project were heard in large numbers while those not interested or opposed for the most part stayed away. The character of the hearings is indicated by the statement of the Executive Director of the Great Lakes-St. Lawrence Tidewater Association, reporting on the administration of his office:

> The International Joint Commission at the insistence of your Association held forty-four hearings in sixteen states of the United States and in five provinces of Canada. More than three hundred citizens appeared and testified before the Commission. . . . Every hearing was arranged, the evidence procured, and its introduction supervised by your Executive Director.[1]

The Commission apparently did not make any attempt to analyze critically the deluge of testimony which was offered as to the availability of traffic for the St. Lawrence route, but contented itself with the statement that it had reached the

[1] *Annual Report* for year ending December 15, 1926, p. 2.

"general conclusion that sufficient trade will seek the new water route, irrespective of new traffic created as the result of the opening of that route, to justify its construction." [2]

II. The Studies Made for the Great Lakes-St. Lawrence Tidewater Association

Two extensive studies have appeared under the auspices of this association; the first [3] a summary of the testimony presented at the 1920 hearings with certain other material added, the second [4] a more extensive exposition of the traffic problem. The latter purports to find some 30,000,000 short tons as "an approximation of the traffic available for movement on the waterway" at present, and that "in due time a general traffic quite similar in nature to that of our existing Atlantic ports will be established." [5]

Consideration will be limited here to the second report, not only because it represents the Association's last word on the subject of traffic, but also because of the shift in emphasis from the days of 1920 when railway congestion and inability to ship entered so largely into prevailing attitudes. What is said here applies, however, in large part also to the earlier book.

The chief criticisms to be made of the Ritter study relate to the method used in deriving the rates expected to obtain on the waterway, its utter failure to give heed to practical marketing and other commercial considerations, and its ambiguous and very misleading use of essential terms. Basic to the entire study is the rate analysis, and to this attention will first be directed.

[2] International Joint Commission, *Report* on St. Lawrence, 1921, p. 184.

[3] MacElwee, R. S., and Ritter, A. H., *Economic Aspects of the Great Lakes-St. Lawrence Ship Channel,* 1921.

[4] Ritter, A. H., *Transportation Economics of the Great Lakes-St. Lawrence Ship Channel,* published by the Association, 1925.

[5] *Ibid.,* pp. 124, 269.

The author derives what he designates as "feasible rates via the Great Lakes-St. Lawrence waterway" by first establishing a "rated scale," intended to express the relationship between the rates he seeks and those obtaining from New York. The method used is merely to assume the extension, proportionate to distances, of the rates applying to New York to reflect the additional cost of moving the vessels to or from the Great Lakes. The "rated scale" is derived from a calculation of vessel operating costs. Thus from Mediterranean ports there would be 17 days of steaming in reaching New York and 23 in reaching Chicago; the six additional days, figured at $480 each (said to be fair for a vessel carrying 4,500 tons of cargo), cost $2,880; which sum, added to the costs to New York, yields a percentage relationship of 119 between the two ports from these particular points of origin. This figure is for tramps; for liners it is 115. Similar ratios are worked out for many other points of origin and destination. These various ratios, applied to the rates at New York, are held to yield the likely rates to or from the same destination via the St. Lawrence.

Before passing to the application made of these ratios, we may note that: (a) they are based on a very limited number and range of vessel operations, (b) they make inadequate allowance for the great difference in conditions obtaining inland from those obtaining at New York, which is unique among ports on the American continent with respect to such important rate-making factors as return loads, "position,"[6] and volume and variety of traffic; (c) they fail to include in the calculations the added insurance and pilotage costs incident to shipping on the St. Lawrence route; and (d) they neglect entirely the effect on vessel operating costs of the seasonal closing of the route.

[6] Lacking a return load at point of delivering a cargo, a vessel should be in a "position" to move economically to a point where a load can be obtained.

The author next proceeds to lay out the area "tributary to the Great Lakes-St. Lawrence Ship Channel." For this purpose he must have some representative rates, out of New York, out of Lake ports, and by rail from inland points to either New York or the Lakes. He chooses the general cargo rate from New York and the fifth class domestic rail rate. The ocean rate he extends by the "rated scale" derived as above to obtain a "feasible rate from lake ports." His problem then is to lay off on a map points where the combination of the rail rate to a Lake port and the water rate thence is lower than the combination rate via New York (in a few instances, other ocean ports are considered as competitive with the Lake ports). Extending this procedure in all directions from the Great Lakes-St. Lawrence system, he finally strikes a zone of indifference and there he sets his boundary. All territory within is tributary to the St. Lawrence waterway; all other is not. Since the spread in rates between New York and the Lake ports would vary with the point of origin or destination of shipments, he derives five "tributary areas," one for trade with the United Kingdom and Atlantic Europe,[7] one for trade with Mediterranean ports, India, and the East Indies, another for the West Indies and Central America, another for South America and Africa, and the last and smallest[8] for trade with the Orient and Australia.[9] Contained in the respective tribu-

[7] The largest area, sweeping down from the Canadian border in Idaho to lower Colorado, thence dipping through central Oklahoma and Arkansas, rising slightly and proceeding eastward across central Tennessee, thence northeast across central West Virginia and Pennsylvania to a point near the New York-Vermont boundary with Canada.

[8] Dropping down from the Canadian border at the western boundary of North Dakota to take in about two-thirds of Kansas, thence rising gradually through points a little below the Ohio River, thence north, skirting Cincinnati, Columbus, and Youngstown and ending at a point on the New York border opposite Cornwall, Ontario.

[9] A separate analysis is made of grain, and to this attention is given in Chapter VII.

tary areas are 42, 40, 33, 31, and 30 per cent of the population of the United States.

Objections to this procedure are almost self evident. (a) How representative is the general cargo rate or the fifth-class rail rate? What specific meaning has such a calculation when applied to higher or lower grades of traffic? (b) What significance has the general cargo rate *from* New York when applied to traffic coming into that port or into interior ports? (c) Obviously, the tributary area would be contracted by a reduction of rail rates or an advance in ocean rates, and *vice versa*. (d) Further, the whole calculation is made on the basis of relative transportation cost alone. No allowance is made for the host of practical marketing and manufacturing considerations which necessarily enter into the determination of the route it is profitable to use for a particular type of traffic, and it is assumed that all requirements as to frequency of vessel service from the Lakes can be met. On these subjects more will be said presently.

So much, in brief, for the method used in deriving "feasible rates" and "tributary areas." The next step in the analysis consists of drawing conclusions as to traffic available and savings to accrue from the use of the route. Here four classes of traffic are distinguished: Imports for direct consumption, imports for use in manufacturing, exports, and movements between the Lakes and our own coasts. Coffee and nuts are examples of the first class.

Assuming the same consumption per capita throughout the country, the percentage of population in the tributary area, relative to the point of origin of the particular commodity is applied to the total importation to derive the "traffic available" under this head. The table on page 283, which deals with coffee, illustrates the method of estimating import traffic of this class.

The process is the same in the case of imported raw materials, except that here the percentage of production in the "tributary" states of the commodities into which the raw

materials enter, based on the Census of Manufactures for 1919, is applied to total imports of the particular commodities to derive the "traffic available." The special objection which lies against this basis of calculation is its failure to recognize that oftentimes, in the case of materials available also from domestic sources, the imports move only to points on or near the coasts.

DERIVATION OF "TRAFFIC AVAILABLE" IN COFFEE [a]

Origin of Imports	Total Imports (Tons)	Percentage of U. S. Population [b]	"Available for Waterway" (Tons)
United Kingdom and Europe	1,600	42	670
India and East Indies	17,380	40	6,950
South America	531,700	31	164,800
Central America and Mexico	68,400	33	22,570
West Indies	3,450	33	1,140
All other	360	..	...
Total	622,890	..	196,130

[a] Adapted from p. 81, Census of Manufactures, 1919.
[b] That is, in the "tributary area" relating to the specific trade zones. See p. 281.

Exports are estimated "as of the same percentage of the total exports of the commodity, as the production of the tributary territory is of the total production of the country." [10] Thus 80 per cent of the automobiles and parts are produced in the "tributary territory," and 80 per cent of our total exports in 1922 equals 115,222 tons of "available traffic." We do not stop to point out at length that the assumption here made may be wholly unjustified in the case of many commodities. Paper, for example, is extensively produced in the Middle West, but little is exported, for reasons which

[10] *Ibid.* p. 78.

the proposed waterway will not materially alter. Many large establishments in various lines of manufacture have coast plants for their export business while using their interior plants to supply the domestic market.

Adding up the various items Mr. Ritter obtains 4,826,022 tons of imports, 15,713,603 tons of exports, and 9,635,000 of domestic traffic, a total of 30,174,625 tons of traffic " available for movement on the waterway."

The expression " available for movement on the waterway " does not imply, as one would suppose, that all this traffic would actually be shipped over the waterway. The author uses some of his terms in a most ambiguous and misleading way. Upon close analysis we find that " traffic available " sometimes means not merely the traffic that might move over the route, but all traffic that might be " subject to the favorable influence of the waterway, including the portion which will move during the season when navigation is closed; " [11] and sometimes it means traffic " available for movement *on the waterway*." Indeed, these widely divergent definitions of this term are to be found in a single paragraph.

Just as misleading is the ambiguous use of the phrase " indicated saving in freight charges per ton." This phrase is not only used in the text, but elaborate tables appear, each of which carries a column thus headed. In ordinary parlance this phrase would clearly signify the amount that the shipper would be ahead if he used the waterway rather than an alternative transportation route. But, as a matter of fact, the author himself recognizes that the " feasible rates " which he derives are not " net savings," that, in addition to freight rates, there are numerous other expenses to be considered.[12]

The form of presentation used is such as to lead any but the most careful reader to reach the conclusion that the figures given in the tables are the real savings which the shipper would realize.

[11] *Ibid.* p. 124.
[12] *Ibid.* p. 79.

Many examples could be given of the failure of the book to give any weight whatever to practical routing and marketing considerations. Some of these have already been mentioned and others are considered in connection with our own studies of individual traffic movements. However, a few may be pointed out here. Certain types of traffic require elaborate and closely knit organizations for their successful handling, such as meats and fresh fruits, (see Chap. VII and Appendix J). No distinction is made between traffic requiring high speed movement and other traffic. The routing of many commodities, such as rubber and coffee, is largely determined by trade practices and the presence of great markets, as at New York, where functions are performed which cannot be dispensed with except at a cost. Per capita or other arbitrary consumption figures are therefore altogether meaningless in the determination of traffic flows. The buyer's control of the routing in the case of exports is left out of consideration, and the rôle of export agents and importers is assigned no importance. Nor is cognizance taken of the cost to shipper in shifting from one type of transportation facility to another.

In summary, the Ritter study violates sound principles of traffic analysis basically by faulty calculations and generalizations as to rates, and by its failure to give heed to the requirements of individual types of traffic and to the whole range of marketing, trade and shipping considerations which in practice enter so largely into the determination of traffic routings.

III. Estimate of United States Department of Commerce

The most recent offering on the subject of the traffic potentialities of the St. Lawrence waterway is a study made by the Transportation Division of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce at the request of Secretary Hoover, who at the time was also chairman of the United States St. Lawrence

Advisory Commission.[13] This report was included in substance in that rendered to President Coolidge by the St. Lawrence Commission on January 3, 1927. Our consideration of this report will relate solely to the parts bearing on the St. Lawrence waterway.

This study finds from 18,600,000 to 23,700,000 long tons of traffic available to move by the St. Lawrence and states further that "in the event either of the proposed waterways is completed, these estimates will soon be considerably surpassed." [14] The amounts stated are considerably less than the total found by Ritter. Of the totals stated, from 8,600,000 to 12,400,000 tons represent exports, 3,000,000 to 4,300,000 tons imports, and 7,000,000 tons trade between the Great Lakes and our three coast regions.

The method of arriving at this estimate of traffic is in essence simple. Our total seaborne traffic in foreign commerce for the year 1924 is used as the starting point. From this are deducted such exports and imports as "would not naturally move via the proposed deeper ship channels" (cotton, tobacco, naval stores, raw silk, iron ore, etc.), and also certain items constituting "traffic to (and from) Mexico and Canada by established routes." The remainder is 20,989,780 tons of exports and 23,008,779 tons of imports, "part of which is potential traffic."

With the eliminations made there can be no serious disagreement, except that there is apparently a considerable duplication between the deductions made on a commodity basis and those made for traffic with Mexico and Canada. It is the ensuing steps which are open to most serious question.

The second step is to ascertain the percentage of this outflow of traffic that originates in some twelve states arbitrarily desig-

[13] Gregg, E. S., and Cricher, A. Lane, *Great Lakes-to-Ocean Waterways—Some Economic Aspects of the Great Lakes-St. Lawrence, Lakes-to-Hudson, and All-American Waterway Projects*, 1927.

[14] *Ibid.* pp. 12-13.

nated as tributary to the waterway. The customs declarations on a group of 34 export commodities for the year 1924 are therefore examined, as these give the point of origin of each shipment. The percentage of each such article of export found to originate in the "tributary territory" in that year is then applied to an average of our total exports of that commodity for the years 1921-1924. So much of the resulting figure as represents shipments during the open season (taken as May to November) is defined as "potential traffic."

To follow through a concrete example: A certain number of tons (not indicated) of galvanized iron or steel sheets was found to originate in the tributary territory in 1924; this amounted to 26.5 per cent of the total exports of this commodity for that year; this percentage, applied to 97,077 tons, the average total exports for 1921-1924, yields 25,739 tons as originating on the average in the tributary territory in that same period. In 1924, 63.2 per cent of our total exports of this commodity moved in May to November; 63.2 per cent of 25,739 tons is 16,267 tons and therefore this amount represents "potential traffic." In the 34 commodities studied, this total is found to comprise 37.6 per cent by value, or 44.1 per cent by weight, of our exports of those commodities.

The next task is to get from the sample to the total. If the sample is assumed to be representative apparently all that is required is to apply to the total of "exports available" (20,989,780 tons), the percentage 44.1, which is the ratio in the sample of potential traffic, in tons, to total export tonnage. This, however, is not done; in fact, no use is made of the tonnage ratio after it has been computed. Instead, the ratio of the *value* of the potential traffic to the value of exports of the commodities studied, 37.6 per cent, is applied to the "traffic available," 20,989,780 tons, giving 7,892,157 tons of "potential traffic." No reason is offered for using a ratio between values to estimate a ratio between tonnages.

Still more inscrutable is the next step. The authors find that the value per ton of the items comprising their sample is $156.80. This amount they divide into the aggregate value[15] of all the exports available, obtaining a new figure of 10,973,328 tons in place of the old figure of 20,989,780 tons which is used as an alternative estimate of "exports available." To this new figure is applied the *value* ratio 37.6 per cent previously used, which gives 4,125,992 tons as an alternative estimate of the potential traffic. These two figures, 7,892,157 and 4,125,992 are used as maximum and minimum estimates of the tonnage of potential traffic in domestic export commodities.

To these figures are added estimates of Canadian export wheat and of the present St. Lawrence canal traffic (without allowance for any duplication, except in wheat, between the export figures previously used and the present St. Lawrence canal traffic). The totals arrived at are 8,611,500 minimum and 12,377,665 tons maximum. These figures are rounded off to the 8,600,000 and 12,400,000 tons mentioned at the outset.

The process is similar in the case of imports, yielding 2,200,000 to 3,500,000 tons of "potential traffic," to which is to be added the present St. Lawrence inbound traffic, giving a total of from approximately 2,600,000 to 4,300,000 tons.[16]

[15] The value figures are derived from sources independent of those used in computing the estimate of export tonnage available. The base is the total value of domestic exports, from which are made deductions for exports to Canada and Mexico and for commodities "which would not naturally move by this route." As in the case of the tonnage figures, deductions of the two types apparently overlap.

[16] The peculiar method used in estimating potential traffic between the Lakes and the coasts will be explained in this place in order not to break into the main thread of the argument. The process used is stated to be based upon "the mathematical combinations of interconnection." In plain English, this means that first the populations of the cities bordering on the Great Lakes and on each of our coasts are determined and also the present trade between such of these regions as now "are properly and closely connected with deep water transportation facilities." The next step is to reason by analogy that, if the Great Lakes cities

Let us consider what significance attaches to results obtained in this way. In essence, the authors merely present a statement of present flows of traffic and imply that all *exports and imports* (except those expressly set aside at the outset) and the "inter-coastal" traffic of the tributary territory moving during the season of open navigation constitute potential traffic for the waterway. Taken literally, their analysis would imply that during the navigation season *every single ton* of traffic moving into and out of the twelve states [17] which constitute the "tributary territory", would leave existing transportation routes for the waterway.

Finally, it must be noted that the authors' base their estimates on the savings that would result from the construction of the waterway primarily on the possible savings in grain rates. "Grain, which will undoubtedly be one of the principal commodities which will flow through the waterway, is taken as a test commodity. It is easier to estimate from various angles the cost of moving a bulk commodity such as grain than multiform general package cargo. It is also logical to assume that if one important commodity can be moved cheaper over an ocean ship route than over existing routes, other commodities can also be moved cheaper than at the present." [18]

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had such freedom of interchange as the coast cities now enjoy, they too would develop an important traffic interchange, the extent of which would be measured by their population and that of the respective coast regions with which they would trade. In all, 7,000,000 tons of traffic are derived in this purely mathematical manner.

Even this somewhat simplified explanation will make it clear that what the authors seek is a measure of total flow of traffic, by whatever agency of transportation, during the season of navigation. Unlike exports and imports, where the finding has at least some statistical foundation, this calculation is based on theoretical considerations which call forth the strongest doubts.

[17] While the tributary area is not as large as that assumed in the Ritter report, it includes Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Iowa, Nebraska, Kansas, and Missouri.

[18] *Ibid.* p. 62.

Is it logical to reason from grain rates to rates on all other types of traffic? Is the grain rate analysis sound?

The grain movement is unique in many respects. It is a large aggregate movement and unit shipments are of large size; loading and unloading methods are entirely different from those used in connection with the general run of commodities; there is a distinct seasonal peak, giving rise to a need for tramp service; the grain traffic is highly concentrated as to points of shipment, transshipment, and delivery; it requires faster service than some classes of traffic, but can put up with slower service than can certain other types of traffic; reconsignment or diversion privileges figure prominently in its routing; and in the extent to which it now makes use of domestic water transportation it is clearly distinguished from the general run of traffic. Perhaps more important than any other considerations is the fact that our grain movement is largely to the United Kingdom and northern Europe, points to which the St. Lawrence gives its maximum advantage, whereas our exports of other commodities may increasingly in the future go to other parts of the world. It is unnecessary to say more to indicate that vessel operating costs and the service requirements of the grain traffic are wholly different from what they are in the case of most other types of traffic. It would, in fact, be impossible to pick out any one item of traffic for use in testing rates.

As to the rate analysis, the alleged saving of from 6.4 to 9.6 cents per bushel is illusory. Complete substantiation of this conclusion is found in Chapter VII. Necessarily, then, the whole superstructure of savings to be realized on other traffic falls with it.

APPENDIX D

FOREST PRODUCTS

I. Lumber

The Middle West has largely exhausted its native timber resources and is dependent on the South and West for its lumber supplies. The Department of Agriculture has estimated that the state of Michigan alone pays an annual freight bill of over $15,000,000 on the lumber which it brings in from other states. Timber and many timber products are naturally adapted to water transportation and traditionally have been important sources of traffic for inland waterways in this country. It is therefore confidently believed that the St. Lawrence would be utilized extensively in the handling of lumber. The various lumber movements which it has been assumed would develop via the St. Lawrence deep waterway are as follows:

Southern yellow pine and southern hardwoods would move south to Gulf ports by rail, thence coastwise via the Gulf, Atlantic, and St. Lawrence into the Great Lakes.

The waterborne lumber trade which has developed between the Pacific Northwest and northeastern seaboard cities would be extended into the Great Lakes.

Tropical hardwoods, such as mahogany and Spanish cedar, which now move from foreign countries of origin to Atlantic or Gulf ports and thence by rail to interior points, would move via the all-water route and be unloaded directly at Great Lakes ports.

In addition to these existing trades, which it is presumed would find the proposed waterway advantageous, it has been argued that pine and spruce from northern Europe might be introduced in Great Lakes territory were an all-water route available.

Also, some of those appearing at the hearings held before the International Joint Commission in 1920 testified that Michigan exporters of maple flooring would ship via the water route.

In the following pages each of these potential sources of traffic will be considered. In the case of such a basic raw material as lumber the problem of analyzing traffic is more complex than these statements of feasible trades indicate. The term lumber covers a great variety of materials which are produced in widely varying quantities, are derived from widely distributed forest regions, and are utilized by a large number of industries. Preliminary, therefore, to making an analysis of these various trades we shall turn our attention briefly to a consideration of Great Lakes territory as a market for lumber. To simplify the discussion we shall omit imports for the present.

A. Great Lakes Region as a Lumber Market

The lake states which are heavy purchasers of domestic lumber from other regions are Illinois, Indiana, Michigan, Wisconsin, and Ohio. Collectively these states annually consume approximately 2.5 billion feet, B. M., of hardwood lumber, and 5.5 billion feet, B. M., of softwood.[1] Of this total lumber requirement less than one-half of the hardwood is produced within the boundaries of these five states and approximately one-sixth of the softwood. The remainder of more than 1.25 billion feet of hardwood and roughly 5 billion feet of softwood is shipped in from other states.

On the basis of present lumber requirements of Great Lakes states our problem, therefore, is one of determining how much

[1] The hardwoods are the broad-leaved trees such as oak and maple. The commercial cut of saw lumber includes 15 species of major importance, 15 of minor importance, and very small quantities of approximately 20 more. The total output of all species for continental United States is roughly 6 billion feet, B. M. annually.

The softwoods are the conifers and evergreens. The commercial cut includes 12 species of major importance and 2 of minor importance. The aggregate output of saw lumber of all softwoods is approximately 30 billion feet, B. M. annually.

of this 6.25 billion feet of lumber which now moves into these states all-rail might find it advantageous to move all-water to lake ports.[2] To solve this problem, however, we shall need to consider two further questions. First, which lumber regions are so situated with reference to Gulf ports and to Pacific ports that they might ship lumber coastwise up the Atlantic and into Great Lakes via the St. Lawrence; and, second, what are the probabilities that lumber moving all-water from Gulf ports or from Pacific ports could compete with lumber moving into Great Lakes territory all-rail, or joint rail and water.

The principal saw timber regions of the United States from which our commercial supply of lumber is obtained are shown graphically on page 294. The quantities of lumber which the five lake states receive and the regions from which their requirements are supplied are shown in the table on page 295.

Study of the map and table brings one to the following conclusions:

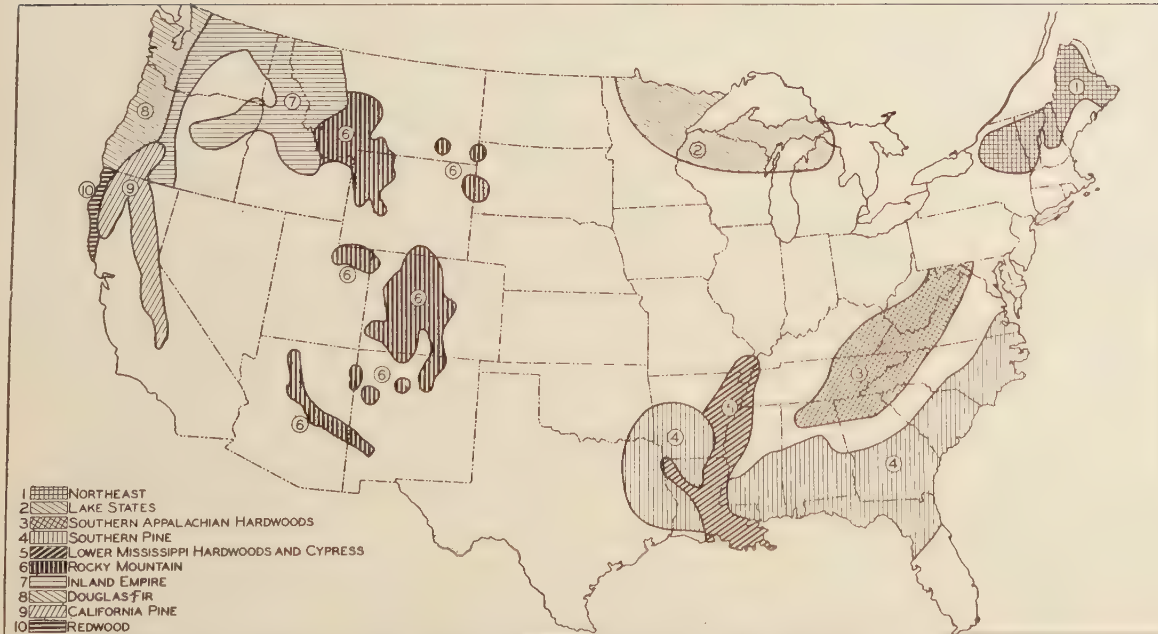
Of the total supply of softwood consumed in lake states roughly one-third originates in regions which are not favorably situated with reference to water transportation. This one-third is made up of lumber derived from the Lakes States forest region, the Inland Empire and Rocky Mountains forest areas, and the California pine area. Two-thirds of the supply originates in regions which might conceivably use the St. Lawrence waterway. These regions are the southern pine area, the redwood area of California, and the Douglas fir region of the Pacific Northwest (this region includes British Columbia).[3]

Of the hardwood regions, only the Louisiana area is so located that it might conceivably utilize a coastwise route,—shipping

[2] Imports of foreign wood are derived principally from Canada and from tropical hardwood areas. Aggregate imports of all species into the lake states are estimated at 2 to 3 per cent of the total lumber movement into the lake states. See pages 315-316.

[3] Imports of Canadian softwood moving across the border into the Great Lakes states averaged 34,000,000 feet for the three years 1923-1925. As this movement would not be affected by the waterway, it is not discussed.

PRINCIPAL SAW-TIMBER SECTIONS OF THE UNITED STATES [a]



[a] Taken from U. S. Forest Service, *Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership* 1920. (In the original, section 8 is called the Pacific Fir Section.)

Domestic Lumber Shipments to Lake States, 1923 [a]

I. SOFTWOOD LUMBER

Source and Species	M Feet	Percentage of Total
Lake States Region:		
Northern Pine	358,571	6.6
Hemlock	508,414	9.3
Southern Pine Area:		
Southern Yellow Pine	2,629,829	48.1
North Carolina Pine	59,823	1.1
Cypress	136,946	2.5
Rocky Mountain and Inland Empire Areas:		
All species	700,768	12.9
California Pine Area:		
All species	275,029	5.0
Redwood Area:		
Redwood	56,687	1.0
Douglas Fir Region:		
All species [b]	736,297	13.5
Total	5,462,364	100.0

II. HARDWOOD LUMBER

Source and Species	M Feet	Percentage of Total
Lake States Region:		
All species [c]	1,221,391	47.0
Southern Appalachian Hardwood Region:		
All species	624,430	23.9
Lower Mississippi Hardwood Region (except Louisiana):		
All species	489,771	18.7
Louisiana Hardwood Region:		
All species [d]	204,974	8.0
All other Hardwood Areas:		
All species	62,015	2.4
Total	2,602,581	100.0

[a] Distribution of softwoods compiled from National Lumber Manufacturers' Association, *National Lumber Handbook*, 1925. Distribution of hardwoods compiled from unpublished records of the Forest Service.

[b] Douglas fir, spruce, and western hemlock are the principal species produced in this region. Douglas fir is the most important wood shipped to the lake states from this region.

[c] Gum and ash are the most important hardwoods shipped to the lake states.

[d] For hardwoods the inter-state and intra-state distribution for the five states—Illinois, Indiana, Michigan, Wisconsin, and Ohio—were taken account of.

by rail to New Orleans and Gulfport, thence by water via the Gulf, Atlantic, and St. Lawrence into Great Lakes ports. See map p. 294. This region, it will be noted, supplies approximately 200 million B. M. feet or 8 per cent of the total volume of hardwood lumber consumed in Great Lakes states.

We are now ready to consider whether any of these regions which have direct access to ports would find it feasible to ship lumber coastwise into the Great Lakes were the St. Lawrence deep waterway available. We shall analyze first the possibilities of a coastwise trade developing between Gulf ports and Great Lakes ports.

B. Southern Lumber as a Source of Traffic for the St. Lawrence

As developed in the preceding section, the southern yellow pine region and the Louisiana hardwood area are two regions of lumber production which geographically may be considered as potential sources of traffic for the St. Lawrence. We may consider first southern yellow pine.

1. *Southern yellow pine.* The failure of southern pine to move coastwise to North Atlantic ports is evidence that it would not use the St. Lawrence. The eight Southern states—Oklahoma, Texas, Arkansas, Louisiana, Mississippi, Alabama, Georgia, and Florida—produce approximately 10 billion feet B. M. of yellow pine lumber a year. Of this total commercial cut of pine lumber, approximately one-fourth is marketed within these states; the surplus cut, or roughly 7.5 billion feet of lumber, is distributed to Great Lakes markets, to North Atlantic coast markets, and to foreign markets.

Since lumber is one of the most important commodities handled through Gulf ports, exceeding 1.5 million tons annually,[4] one might expect to find a large coastwise movement

[4] For the year ending June 30, 1924, 20 per cent of the total volume of exports moving through New Orleans was lumber and lumber products; 60 per cent of the volume moving through

of lumber between Gulf ports and northeastern seaboard cities. Analysis of the trade, however, shows that such traffic is negligible.[5] Less than 5 per cent of the lumber moving from the Southern states into the Atlantic northeast is transported by coastwise vessels. The New England states, New York, Pennsylvania, Delaware and New Jersey, import from the Southern states approximately three million tons of lumber a year. Of this total amount something under 150,000 tons move south to Gulfport, Mobile, and Pensacola by rail, thence by the all-water route to northeastern parts.[6] The remainder of this

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Mobile was lumber; 69 per cent of the volume through Pensacola; and 97 per cent of the volume through Gulfport, Mississippi, was lumber. Percentages are computed from data compiled by Bureau of Research, United States Shipbuilding Board, *Report on Volume of Waterborne Foreign Commerce of the United States by Ports of Origin and Destination, Fiscal Year, 1924.*

[5] The North Carolina pine region ships over half its output coastwise, principally through the port of Norfolk, Va., and it might be thought that this section of the southern pine area could develop markets in Great Lakes territory. An analysis of the existing waterborne trade, however, shows that it enjoys peculiar advantages which would not apply in the case of the St. Lawrence. The principal markets are Baltimore, Philadelphia, and New York. Shipments are made in sea barges (which are more economical than steamers), and the water haul is approximately the same as the rail haul, the distance from Norfolk to these points by either route ranging from 200 to 350 statute miles.

The water haul from Norfolk, Va., to Chicago would be 3,000 miles or ten times that of the haul from Norfolk to Baltimore. Moreover, a considerable part of the material shipped by water from the North Carolina pine region is low grade material, box shooks and pitwood for the anthracite mines of Pennsylvania. The St. Lawrence, therefore, could not expect to obtain traffic from this source, since there would be no practical economy in shipping this material such a long distance into a territory which now has access to the low grade stock of the Michigan and Wisconsin hemlock area.

[6] The basis of these computations is as follows: The total movement of lumber from the southern pine region (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, and Texas) into northeastern states was obtained from data compiled by the Forest Service on the distribution of lumber for 1923. See *Census of Manufactures;* 1923, "The Principal Lumber Industries," pp. 52-56. Estimates of the volume of lumber moving coastwise

trade moves from points of production all-rail into Eastern territory.

Comparisons of rail and water distances are very unfavorable to the St. Lawrence route. The average distance from Gulf ports to Great Lakes cities via the proposed St. Lawrence route would be approximately two and one-half times the coastwise distance from Gulf ports to northeastern seaboard cities.[7] The average rail haul from the Southern lumber states to Great Lakes cities is shorter than the average rail haul from the same area to the North Atlantic coast cities. The ratio of water to rail distances in the case of Great Lakes cities, therefore, would be very much greater than it is in the case of these Northeastern seaboard cities. Even if an extensive coastwise lumber trade existed between Gulf ports and the North Atlantic seaboard, it would still be necessary to consider whether a coastwise lumber traffic would be likely to develop over the much longer water-route. In this connection it must be remembered that use of a coastwise route would involve a considerable rail haul in assembling lumber at Gulf ports. In view of the fact that no extensive coastwise lumber traffic has developed between Gulf ports and the North Atlantic coast, there is no reason for believing that a waterborne lumber traffic would develop over the much longer roundabout water route from Gulf ports to Great Lakes cities.

2. *Louisiana hardwood lumber.* We many next consider whether the Louisiana hardwood area might ship a part of its lumber output into northern markets via the Gulf, the At-

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from Gulf ports to North Atlantic coast ports are based on information obtained from the Southern Pine Association and from District Engineers, United States Corps of Engineers, located at Mobile and Pensacola.

Coastwise shipments are reported in short tons. Figures on distribution are reported in M feet, B. M. and are converted to short tons on the basis of one and one-half tons to the M feet.

[7] From Mobile, Alabama, to New York City via the shortest navigable route is 1,669 nautical miles; from Mobile to Chicago via the proposed St. Lawrence route and the Great Lakes is 4,061 nautical miles.

lantic, and the St. Lawrence. To answer this question we must first note the present organization of this trade. Louisiana ships approximately 200 million feet (300,000 short tons) of hardwood lumber into the Great Lakes states annually. Marketing is regular throughout the year. Manufacturers order a few carloads of material at a time, never stocking more than a few cars ahead. It may be estimated, then, that roughly 5,000 to 6,000 tons a week of hardwood are sent north from Louisiana for distribution in the Great Lakes states. We may now consider the feasibility of handling this material over a water route.

The slowness of service via the water route would prevent any extensive coastwise movement of Louisiana hardwoods. The water distance from New Orleans to Chicago is 3,993 miles. The actual sailing time between these two ports would vary from 20 to 30 days. Transshipping would require another five days at either end of the route. A total of 30 to 40 days would therefore be required for handling lumber over this route. The time in transit all-rail from Louisiana to Chicago would not be more than four or five days. It is therefore quite unlikely that hardwood dealers would make any extensive use of a roundabout water route. It might be argued, however, that some traffic would develop, if the boats were available. Hence we must look at the problem from the ship owners' viewpoint.

Vessel operators would not offer the service required by the hardwood industry. Looking at the present north-bound traffic in Louisiana hardwoods from the vessel owners' point of view, it is quite clear that a regular line of boats would not be put in service between New Orleans and the Great Lakes to compete with the railroads for this business. Assuming that the entire north-bound weekly shipments of Louisiana hardwoods could be assembled at New Orleans, loaded on one boat and discharged at one lake port, it would still require eight or nine boats to maintain a weekly service between New Orleans and Chicago. If each boat transported only a part cargo of lumber, obviously 25 or 30 boats would have to be operated over this route to deliver 5,000 or 6,000 tons of lumber weekly at Great

Lakes ports.[8] There is no evidence, however, that the shippers of the classes of goods sent south for consumption—machinery, general merchandise and manufactured products—would be at all interested in a roundabout coastwise water route to southern points. Hence there is no reason for believing that coastwise vessels attempting to handle Louisiana hardwood (northbound) into the Great Lakes ports would be able to obtain any return traffic. But the operation of from eight or nine boats up to 25 or 30 boats for handling one bulk commodity only over a 3,900 mile route and without return cargo is obviously impractical.

We conclude, therefore, that Louisiana hardwoods would not move into Great Lakes territory via a coastwise route, and hence make no allowance for this commodity in our estimates of potential traffic for the St. Lawrence.

C. Pacific Coast Lumber as a Source of Traffic for the St. Lawrence

In this section we shall consider the possibility of developing a waterborne lumber trade between the ports of the Pacific Northwest and Great Lakes cities. As was shown earlier in our discussion, there are two forest regions, the Douglas fir area of Washington, Oregon, and British Columbia, and the California redwood forests, which are directly tributary to Pacific ports and which might conceivably ship lumber via an all-water route into Great Lakes territory. (See map, p. 294.) We shall analyze first the traffic possibilities for the Douglas fir area.

1. *Douglas fir.* Of all our North American forest regions the Douglas fir area of the Pacific Northwest requires the most

[8] It may be pointed out further that in the case of red gum, which is the most important species shipped north from Louisiana, stowage would have to be arranged with special care to prevent warping and water staining.

careful study as a source of potential traffic for the St. Lawrence. It has enjoyed for 30 years an enormous waterborne trade and still has available an estimated stand of more than 600 billion feet of saw timber in the United States, and another 100 to 366 billions of feet in British Columbia.[9] In the last six years this region has shipped to North Atlantic coast ports via the Panama Canal a total of more than six billion feet of lumber. If the costs of water transportation, therefore, are very much lower than the costs of transportation by rail, it might very well be that the opening of the St. Lawrence route would stimulate an extensive waterborne lumber trade between the ports of the Pacific Northwest and the Great Lakes. Our problem, then, in the case of Douglas fir is one of determining whether the cost of transportation by water would be materially lower than by rail.[10]

Preliminary, however, to making a comparison of rail and water rates it is necessary to look at the market situation. For Douglas fir to enter Great Lakes territory via an all water route it would have to meet the competition, not only of Douglas fir moving all-rail, but also the competition of Douglas fir and other softwoods entering that region by all other routes. The competition which it would have to meet may be noted:

First, Douglas fir entering the Chicago market via an all-water route would have to meet the competition of Douglas fir moving into that market all-rail, and the competition of southern yellow pine moving all-rail.

Second, Douglas fir entering Buffalo-Pittsburgh territory via an all-water route would have to meet the competition not only

[9] Estimates of Canadian reserves vary widely because of a difference of opinion as to how much of the stand will ever be accessible to loggers. See Zon, Raphael, and Sparhawk, William N., *Forest Reserves of the World,* Vol. II, p. 498.

[10] In addition to Douglas fir, the Douglas fir region includes western hemlock, spruce, red cedar, and true firs. Since Douglas fir is by far the most important species and the principal competitive wood to southern yellow pine, we have simplified our analysis for this region by limiting the discussion to Douglas fir.

Domestic Softwood Lumber Shipments to Certain States in 1923 [a]

Specie and Source	Illinois		Ohio		Michigan		Wisconsin		Indiana		Total	
	M. Feet	Per Cent	M. Feet	Per Cent	M. Feet	Per Cent	M. Feet	Per Cent	M. Feet	Per Cent	M. Feet	Per Cent
Southern yellow pine......... From Southern Pine Area	1,048,562	51.1	700,526	63.9	394,707	45.0	33,478	4.0	452,556	75.7	2,629,829	48.1
Other pine and similar woods.. From Douglas Fir Region	409,853	20.0	53,928	4.9	82,690	9.4	129,427	15.4	60,399	10.1	736,297	13.5
Western pine region and Colo..	240,499	11.7	75,594	6.9	175,268	20.0	188,984	22.5	20,423	3.4	700,768	12.8
Northern pine region.........	120,762	5.9	46,447	4.2	48,305	5.5	132,529	15.8	10,528	1.8	358,571	6.6
California pine region.........	80,779	3.9	53,950	4.9	32,546	3.7	102,183	12.1	5,571	0.9	275,029	5.0
East and Northeast and N. C..	...	...	59,823	5.5	...	..	..	..	...	...	59,823	1.1
Total pine and similar woods.	1,900,455	92.6	990,268	90.3	733,516	83.6	586,601	69.8	549,477	91.9	4,760,317	87.1
Hemlock.................... From Wisconsin and Michigan	100,260	4.9	25,783	2.3	118,196	13.5	243,966	29.0	20,209	3.4	508,414	9.3
Cypress.................... From all Cypress Areas except Louisiana	35,972	1.8	62,423	5.7	15,477	1.8	3,517	0.4	19,557	3.3	136,946	2.5
Redwood.................. From California Redwood area	14,185	0.7	18,509	1.7	9,386	1.1	6,117	0.8	8,490	1.4	56,687	1.1
Total softwoods...........	2,050,872	100.0	1,096,983	100.0	876,575	100.0	840,201	100.0	597,733	100.0	5,462,364	100.0

[a] Computed by the National Lumber Manufacturers' Association from 1923 data compiled by them and from U. S. Census Reports of 1922 and 1923. The tabulation covers approximately 95 per cent of the total domestic distribution of softwood lumber. National Lumber Manufacturers' Association, *National Lumber Handbook*, April, 1925, pp. 8-9.

of northern pine and southern yellow pine, but also the competition of Douglas fir moving all-water to New York or Baltimore and thence inland on a rail haul.

Third, Douglas fir moving via an all-water route into Detroit or Cleveland territory would have to meet the competition of southern yellow pine, since those markets consume largely southern yellow pine at the present time.

We shall analyze first the possibility of Douglas fir moving via an all-water route from Seattle or Portland to Chicago, in competition with Douglas fir moving all-rail from those points to Chicago. Of the total volume of softwood consumed in Illinois, at the present time, 20 per cent is Douglas fir. (See table on accompanying page.)

a. *Chicago territory.* A comparison of all-rail rates with estimated all-water rates via the Atlantic and St. Lawrence route indicates a slight margin in favor of rail transportation. The rail rate on lumber moving in carload lots from Seattle or Portland to Chicago is $14.40 per short ton. Water rates from the Pacific Northwest port to North Atlantic coast ports. quoted on a measurement basis, have varied from $15.00-$16.00 to as low as $9.00-$10.00 per M feet since the depression of 1921. As a fair figure representing the somewhat improved tonnage situation (from the vessel owner's standpoint) which has prevailed recently, we may use $15.00 per M feet as the going rate for this trade.

To compare these figures it is necessary to put them on the same basis. Weights per M feet for Douglas fir timber and other lumber products and equivalent rail rates are shown in the table on the following page.

If we compare these rail rates with a rate of $15.00 per M feet on Douglas fir moving all-water to North Atlantic coast ports, it will be seen that Douglas fir flooring and drop siding now move to Chicago for approximately the same freight cost that they pay to Atlantic coast markets. Clearly they could not use an all-water route to enter Chicago markets. For the other lumber products the spread between the all-rail rate to

Chicago and the water rate to North Atlantic coast ports varies from \$2.00 per M feet on boards to \$5.16 per M feet on timber. Our problem then is to see which of these products, if any, might be shipped to Chicago markets all-water at a lower cost than they now move by rail. To make the analysis as simple as possible we shall consider how much the differential between the rail rate to Chicago and the all-water rate to Atlantic coast ports on timber might be reduced.

RAIL RATES PER M FEET ON DOUGLAS FIR, WEST COAST TO CHICAGO [a]

(In carload lots)

Product	Pounds per M Feet [b]	Rail Rate per M Feet
Timbers	2,800 [c]	\$20.16
2 x 4 x 16 feet fir dimension	2,600	19.20
Common 8-inch and 10-inch fir boards	2,500	17.00
No. 2 V. G. fir drop siding	2,000	14.40
No. 2 fir flooring	2,000	14.40

[a] The rail rate used is the rate Seattle to Chicago, 72 cents per 100 pounds.
[b] Weights except for fir timber are commercially dry shipping weights, as given in *Lumber and its Utilization*, National Lumber Manufacturers' Association, 1924.
[c] Weight for timbers is based on air-dry weight per cubic foot, as reported by Forest Products Laboratory, U. S. Department of Agriculture.

What it would cost to operate a vessel over the longer route Seattle to Chicago all-water, compared with the trip from the Pacific Northwest to North Atlantic ports is, of course, very difficult to say. With the question of developing the St. Lawrence still an open one, vessel operators have had no occasion to express an opinion as to what rates should be charged either in the intercoastal lumber trade or any other specific trade proposed for the St. Lawrence. Taking into account the fact that the distance to Chicago from Seattle is more than one-

third greater than it is from Seattle to New York, and the further fact that the Great Lakes ports would not enjoy any striking advantages compared with the Atlantic coast cities in building up an intercoastal trade, \$5.00 per M feet above the rate to North Atlantic cities would seem about the minimum on which operators could afford to do business between Seattle and Chicago. On a \$15 basis to North Atlantic coast ports this would bring the rate up to \$20 per M feet and would leave only \$1.60 in favor of the water route, compared with the all-rail rate to Chicago.

In order, however, not to seem unfavorable to the route, we shall make our computations on the basis of Mr. Ritter's estimate of a feasible water rate on lumber to Lake Michigan ports.[11] In his judgment \$3.75 per M feet to Lake Michigan ports would be a reasonable advance in the lake rate above the intercoastal rate. This advance would give us a total rate on timbers of \$18.75 per M feet to Chicago and leave a saving of \$2.41 per M feet in favor of the all-water as compared with the all-rail route.

But it must be pointed out that both of the computations above are made on the basis of intercoastal rates prevailing on lumber at the present time. Looking toward the future the general level of rates will undoubtedly be higher as soon as the shipping industry recovers from the surplus of tonnage with which it has been burdened since the close of the war. How much higher the general level of rates will be is a question beyond the scope of our present inquiry. In the lumber trade it may be noted that rates fluctuate on a minimum of 50 cents and frequently on a dollar basis. On round trips above 10,000 miles, advances on lumber of \$2.00 or \$3.00 per M feet would certainly seem conservative estimates. If we add only a nominal increase of one dollar to the rate to North Atlantic coast ports and fifty cents for the additional distance into the Great

[11] Mr. Ritter uses a basic rate of \$15.00 per M feet to North Atlantic coast ports. See Ritter, *The St. Lawrence Ship Channel*, p. 118.

Lakes we have made the lowest allowance which we can, almost a nominal one, for a general increase in the level of ocean rates. Such an allowance would bring the all-water rate on Pacific Coast lumber moving to Chicago up to $19.75, leaving a saving of 41 cents in water transportation costs compared with the cost by rail.

The next factors which we must consider are the terminal facilities at ports of discharge and the restricted channels of the proposed waterway. Obviously, the seasonal character of the route would prevent the investment of large amounts of capital in expensive terminal plants such as have been developed at North Atlantic coast cities by some of the large timber interests,[12] or in large terminal yards such as are being developed at Boston.[13] Discharging of lumber at Great Lakes ports would have to be done largely by stevedores and ship's tackle, and the time required for turn-around at Great Lakes ports would undoubtedly be greater than at Atlantic coast ports. There is no question, also, but that the restricted channels of

[12] "The distributing terminal of the Weyerhauser Timber Company at Baltimore will have a storage capacity of 100 million feet of lumber. The yard contains 6 fire-proof lumber sheds . . . These sheds are equipped with 5-ton traveling electric cranes which lift the unit loads from the industrial cars and place them in storage piles, 30 feet high by 70 feet wide. . . .

"The plant is equipped with a planing mill, stacker, dry kiln, cooling shed and unstacker. On either side of the lumber pier is a timber pond formed by poling and a timber boom where timbers are unloaded from ships. The timbers are taken ashore on endless chains and placed on rolls and moved to two timber sheds, 76 x 990 ft. long, located beside the lumber sheds. To the rear of these sheds is the saw mill operated by electricity. . . . The piers and the ponds, loading and timber sheds are all served by standard railroad connections." *Timberman*, February, 1920, p. 97.

[13] "The 50-acre terminal is now approaching completion, equipment including cranes covering every foot of yard space is rapidly being installed. . . .

"The Wiggin terminal is organized with ultimate capacity for 125,000,000 feet of waterborne west coast lumber, in addition to ample space for other varieties of incoming and outgoing freight." *The Four L Lumber News,* October 10, 1926.

the St. Lawrence and the Great Lakes would increase the time required for navigating the proposed route compared with navigating an equal distance on the high seas. Here, again, it is difficult to determine how much of an increase in rates would be required to compensate for the losses of time. When business was dull owners would obviously make some sacrifice in this respect, since many operators consider it better business policy to keep boats employed than to let them lie idle and thereby tend to add to the excess tonnage at any given time.

When, however, there was any competition at all for tonnage in the lumber trade out of Pacific Northwest ports, it would be our opinion that at least $1.00 per M feet on lumber would be asked by vessel operators to compensate for the loss of time on account of slow speed through the St. Lawrence route and slow discharge at Great Lakes ports. Such an allowance would bring our intercoastal rate on timbers, Seattle to Chicago, up to $20.75 per M feet, and would make the all-water route 59 cents higher than the rail rate.

We may now summarize our findings thus far. By making the very lowest allowances for the increase in distance to Chicago as compared with the distance to North Atlantic coast ports, for the probable increase in the general level of ocean freight rates, and for the additional charges which operators would want on account of slow navigation through the St. Lawrence and slow discharge at port, we have an estimated loss of 59 cents per M on timbers shipped to Chicago via an all-water route. On dimensions shipped via the all-water route the ocean freight would be $1.55 higher than the rail freight rate, and on boards the ocean freight would be $3.75 higher than the rail rate. This is the situation from the rate angle. In itself it may be taken as proof that practically all these lumber products originating on the West coast would not move via a water route into Chicago territory. Since it may be contended, however, that the estimated loss on timber moving all-water is very low, and that lumber would move by the water

route during periods when ocean rates were depressed, we may consider the all-water route from the lumber dealer's point of view.

Since a lumber dealer would incur additional expenses and risks in using the water route which he would not have to bear if he shipped all rail, it seems quite unlikely that even Douglas fir timber in any quantity would ever utilize the St. Lawrence route in reaching the Chicago market. As these losses and risks are tied up with the slowness of the water route, we may compare briefly the all-rail route and the water route. The time in transit of lumber shipments moving all-rail from Portland or Seattle to Chicago is 9 to 12 days. The time in transit from the Pacific Northwest to North Atlantic coast ports varies from 21 to 30 days.[14] The steaming time for the boats of the Canadian Government Merchant Marine between Vancouver and Montreal is 34 days.[15] The distance from Montreal to Chicago via the St. Lawrence and Great Lakes channels is 1,065 nautical miles. Four or five days at least would be required to steam this extra distance, and more likely six, since actual sailing schedules of ocean vessels are not up to theoretical efficiency. Based on the record of the Canadian intercoastal carriers, then, the total distance from Puget Sound to Chicago by boat would require 39 or 40 days.

Even if it were assumed that common carriers such as the Luckenbach Line could develop a general intercoastal business into Great Lakes ports during the open season under the same conditions of efficiency as they enjoy at the Atlantic Coast cities, the time for making the trip might be increased only

[14] The Luckenbach boats which maintain a fast intercoastal liner service make the trip from Puget Sound to Philadelphia in 21 days (including calls at Oakland, San Francisco and Los Angeles). Large vessels chartered by the Weyerhauser Timber Company carry full cargoes of lumber from Puget Sound to Baltimore in 25 days. Records for three small boats (2,000 to 3,500 gross tons) show an average time in transit of 30 days between Puget Sound and New York.

[15] Information obtained through courtesy of the Canadian Government Merchant Marine, Ltd.

proportional to distance; this would still give us 28 days by water to Chicago compared with 9 to 12 by rail.[16]

These comparisons are for the actual time in transit of lumber shipments moving by the two routes. Were the time required for loading and discharging taken into acccount also, the differential in favor of the rail route would undoubtedly be still greater. The time required for loading ocean vessels varies from 6 to 14 days, depending on the size and type of boat; the time required for discharging varies from 12 to 20 days. No data are at hand on the average time required for loading rail cars or the amount of time lost in freight yards at the point of destination, but it is unlikely that this extra time would average as many days as it does in the case of water transportation. In order, however, to be liberal, we have made no allowance for this factor in comparing the two routes.

But, even without adjustment for this loss of time in port a water haul of 28 to 40 days compared with a rail haul of 9 to 12 days must be recognized as a disadvantage of the water route. Chicago dealers attempting to bring in their west coast lumber requirements via the St. Lawrence would have to estimate their needs farther in advance than dealers handling lumber all-rail; they would have to pay insurance on stock in transit; bear the indirect cost of having their money tied up for a longer period of time than would be required if they shipped all-rail; and likewise incur the risk of price fluctuations over a longer period of time than would be necessary if they shipped all-rail. So far as Chicago lumber dealers are concerned, therefore, we must conclude that the St. Lawrence waterway would not stimulate a water-borne trade in west coast lumber.

There is, however, some possibility that automobile manufacturers located at Great Lakes ports would bring in some

[16] It must be noted, however, that the Luckenbach boats have too great a draft to permit them to use a 27-foot navigation channel. In fact four fifths of the boats engaged in the intercoastal trade could not navigate a 27-foot channel.

lumber from the Northwest region for their own use. In Appendix F-VI (p. 438) we have reached the conclusion that Ford automobiles might be transported in Ford Company boats by way of the St. Lawrence, the Atlantic Ocean, and the Panama Canal to Pacific coast cities. If so, the boats unloading at Pacific Northwest ports would doubtless carry lumber on the return voyage as backhaul traffic. While it is very difficult to set any precise figure, we arrive at an estimate of 20,000 tons per annum.

b. *Buffalo-Pittsburgh territory.* We shall now analyze the possibility of Buffalo lumber interests bringing in Douglas fir via the all-water route for distribution in western New York and Pennsylvania. Unlike Chicago territory, this market does not distribute any quantity of Douglas fir at the present time. We shall therefore need to approach our problem somewhat differently.

First, it is necessary to consider very briefly the market situation. The principal softwoods handled in the Buffalo wholesale district are northern white pine (derived from the lake forest region of the United States and from Canada) and southern yellow pine. Douglas fir is available on either an all-rail haul from Seattle or Portland or on a combination water and rail haul via New York, but very little Douglas fir lumber of any grade is received by either route.[17]

Douglas fir could not enter Buffalo territory by the all-water route in competition with Douglas fir moving into Buffalo on a combination water and rail haul. The higher grades of Douglas fir lumber received at New York City by water move inland as far as Rochester, New York, on a rate of 21½ cents per 100 pounds. Almost no Douglas fir enters the Buffalo market from the Atlantic coast on a rail rate of 26½ cents per 100 pounds. Pittsburgh pays 22 cents per 100 pounds on

[17] The Buffalo wholesale market handles about 60 billion feet B. M. of white pine a year and 6 million feet B. M. of southern yellow pine. Information obtained from Prof. R. J. Hoyle, New York State College of Forestry.

Douglas fir shipped from Baltimore. Practically no Douglas fir moves farther west than Pittsburgh on a combination water and rail haul. Using an average of $15.00 per M feet, then, as the rate from Pacific Northwest ports to North Atlantic coast ports we have joint water and rail rates as follows on Douglas fir flooring and drop siding moving into Buffalo-Pittsburgh territory: to Buffalo $20.30 per M feet, to Pittsburgh $19.40 per M, to Rochester, N. Y., $19.30 per M.

For Douglas fir to enter Buffalo-Pittsburgh territory via the St. Lawrence water route, therefore, it is obvious that it would have to enjoy a water rate lower than $20.30 to $19.30 per M feet, the maximum transportation charge which it can now pay and compete in this territory with northern pine and southern yellow pine. We have then to consider the feasibility of vessel owners offering a rate under $20.50 per M feet for transporting Douglas fir from the Pacific Northwest to Buffalo.

The detailed computations which are necessary to arrive at an estimate of a feasible water rate for lumber moving from the Pacific Northwest to Buffalo need not be repeated, since our method is the same as was used in analyzing the Chicago market, and the factors to be considered are the same. Moreover, with the exception of the comparative distances involved in the two trade routes, there is no basis for making our estimated rate to Buffalo lower than it would be to Chicago, since the probable increase in the general level of ocean freight rates, and the loss of time on account of slow speed through the St. Lawrence River and slow discharge of cargo would affect the rate to Buffalo just as much as they would the rate offered to Chicago. For the additional distance, compared with the trips to North Atlantic ports, we may use an allowance of $2.70 above the rate to North Atlantic ports.[18] We would have then an estimated rate of $19.70 per M feet on Douglas fir lumber

[18] On a rate basis of $3.75 to Chicago, above the intercoastal rate to North Atlantic coast ports, Mr. Ritter uses a rate of $2.70 per M feet on lumber to Lake Erie ports. Ritter, *The St. Lawrence Ship Channel,* p. 118.

moving via an all-water route to Buffalo, compared with the maximum rate of approximately $21.00 (joint rail and water) which Douglas fir can pay in this territory and compete with other softwoods. This computation gives a margin of 80 cents a M feet in the ocean freight rate in favor of the all-water route to Buffalo as compared with the joint water and rail rate.

A Buffalo lumber dealer would not have to incur any more risks and incidental expenses in using the all-water route than the New York dealers who now bring in lumber from the west coast. A possible saving of 80 cents per M feet on freight rates, however, does not seem a wide enough margin to compensate the Buffalo dealer for the inconvenience of dealing part of the year with west coast lumber producers and part of the year (during the closed season of navigation) with the New York lumber dealers. Moreover, such a margin of saving in freight rates would not be great enough to induce the Buffalo dealer to store lumber against his requirements after the St. Lawrence were closed. We see no reason, therefore, for anticipating the development of a water-borne lumber trade between the West coast and Buffalo territory.

c. *Cleveland-Detroit territory.* Finally, we may consider the possibility of Douglas fir entering Cleveland-Detroit territory via an all-water route. This territory at the present time handles principally southern yellow pine and Michigan and Wisconsin softwoods. Michigan's consumption of Douglas fir is only 10 per cent of her total volume of softwood used annually. Ohio's consumption of Douglas fir is only 5 per cent of her total volume of softwood.[19] Our problem in the case of Cleveland-Detroit territory then is to determine how low a water rate would be required to enable Douglas fir to enter this territory in competition with other softwoods. This question we can not answer directly. Considerable light on the problem, however, may be obtained by comparing the rate situation in this territory with that in Buffalo-Pittsburgh territory. It is un-

[19] See table on p. 302.

likely that Douglas fir could enter Cleveland-Detroit territory in competition with southern yellow pine.

Two facts may be noted. First, a study of rail rates shows that Pittsburgh, Cleveland, and Detroit pay practically the same car lot rates on southern yellow pine moving from points of production into their respective territories. Second, as was stated in our analysis of Buffalo-Pittsburgh territory, Pittsburgh is the western limit for Douglas fir moving inland on a rail haul from North Atlantic coast ports. The total rate to Pittsburgh was shown to be approximately \$19.40 per M feet (\$15.00 via the water route from the Pacific Northwest to Baltimore, plus a rail charge from Baltimore to Pittsburgh of \$4.40 per M). But it has also been shown that owners would not find it feasible to make an all-water rate on Douglas fir moving from the Pacific to Buffalo which would be appreciably lower than the joint rail and water rate. Since Cleveland and Detroit are somewhat farther up the lakes and would require some extra sailing time for making the trip, and since there are no other offsetting advantages for this particular territory as compared with either the Chicago or Buffalo market, we conclude that Douglas fir would not find it feasible to enter Lake Erie ports via an all-water route.

2. *California redwood.* In addition to Douglas fir, it will be recalled that California redwood has been listed as potential traffic for the St. Lawrence waterway.[20] A brief survey of the redwood industry indicates that a waterborne traffic would not develop between this forest region and Great Lakes ports.

The failure of redwood to move intercoastally to North Atlantic ports is evidence that it would not use the St. Lawrence route. Inquiries made by the National Lumber Manufacturers' Association show that in spite of the very low charter rates which have prevailed in the intercoastal lumber trade during the last six years and the enormous cargo trade which has de-

[20] Mr. Ritter estimates the saving on redwood moving by the all-water route at \$8.30 per ton to Buffalo; \$7.60 per ton to Detroit; and \$4.30 per ton to Chicago. See *The Great Lakes-St. Lawrence Ship Channel,* p. 11.

veloped in Douglas fir, redwood has not moved via the Panama Canal to North Atlantic coast ports. Their findings may be quoted: [21]

> Prominent lumber manufacturers estimate that 95 per cent of the redwood shipments, both to Middle Western and Eastern states, go by rail.[22] This is due to the fact that much of the material is worked dry stock and the weight of this finished product is so low that the cost of rail transportation is very little more than water transportation. Another reason is that the large steamers operating through the Canal do not like to go into Humboldt Bay or to the open ports on the Mendocino coast and if the redwood is first shipped to San Francisco and then reshipped, the cost of water transportation is considerably higher.

Our conclusions, in view of these conditions, are therefore obvious. Since the redwood lumber industry has not found it practical to ship lumber to North Atlantic coast ports via the all-water route, there is no basis for anticipating the development of a waterborne redwood trade via the much more roundabout and seasonal route which the St. Lawrence would afford.

D. Tropical Hardwoods as a Source of Traffic for the St. Lawrence

The lake states are important manufacturers of furniture and use in addition to domestic hardwoods a considerable volume of imported cabinet woods. Imported woods other than purchases made from Canada now move by boat from countries of origin to North Atlantic or Gulf ports, thence by rail to interior points. In considering the feasibility of shipping foreign woods directly to lake ports, we shall note first the species imported.[23]

[21] National Lumber Manufacturers' Association, *National Lumber Handbook,* 1925, p. 5.

[22] Reports from representative mills indicate a total distribution of redwood to the New England states, New York, New Jersey, and Pennsylvania, of 30 million feet B. M. for 1923. *Ibid.,* p. 5.

[23] Since imports of Canadian hardwoods move directly across the border, principally from lower Ontario, they are not considered in this analysis.

Total imports of tropical hardwoods, other than mahogany, are very small in volume. The United States receives from the tropics, in addition to mahogany, small quantities of Spanish cedar, rosewood, satinwood, and other fine cabinet woods. Aggregate imports of all species, other than mahogany, however, will not average more than 2,000 to 4,000 tons (one to two million board feet) per month. Such a volume of imports derived from a number of geographic regions, and destined to all parts of the United States, obviously need not be considered in connection with the St. Lawrence. We may turn our attention, therefore, to the single species, mahogany.

United States imports of mahogany will average roughly 11,000 tons per month. Imports of mahogany are principally in the form of logs and vary in amount from 50 to 75 million feet B. M. per year (100,000 to 150,000 tons). New Orleans and New York are the principal ports of entry. We may, therefore, consider whether Midwest lumber dealers might not find it feasible to import this particular species direct via the water route. We shall turn our attention to the sources of supply.

Mahogany entering the United States comes principally from the Caribbean area (Mexico and Central America) and from West Africa. From the former area United States imports of logs, during the months the St. Lawrence is open, average 7,000 tons (three and one-half million feet B. M.) per month; from Africa they average 3,000 tons (one and one-half million feet, B. M.) per month.

The lake states manufacture less than one-half of our furniture output. On the basis of the present organization of the furniture industry, we would have then 3,500 tons of mahogany from the Caribbean and 1,500 tons from West Africa as the maximum tonnage per month which mahogany imports might conceivably furnish for the St. Lawrence. Mahogany logs are suitable for handling on a full cargo basis and are now imported, particularly from the Caribbean area, in chartered vessels.

Factors unfavorable to direct shipment to lake ports are the roundaboutness of the all-water route and the character of the industry. Practically all of the mahogany logs imported into this country at the present time are made into veneers and other furniture stock by a few companies who specialize in the handling of mahogany. Importation of mahogany logs direct at lake ports would therefore involve some reorganization of the industry. We are not able, however, to obtain any information on the feasibility of such adjustments.

For the purpose of a traffic estimate, we shall assume that one-half the mahogany brought into Great Lakes territory during the summer months might use the St. Lawrence route. We shall also assume a growth of 50 per cent in the mahogany requirements of Great Lakes territory. We have then 15,000 tons of mahogany imports from the Caribbean area and perhaps 6,500 tons from West Africa as potential traffic for the St. Lawrence.

E. Northern Europe as a Source of Lumber Traffic for the St. Lawrence

In addition to our domestic softwoods it has been assumed by some that spruce and pine from the Scandinavian Peninsula and Finland might enter Great Lakes markets were water transportation available. In this section we shall consider the probability of such a lumber traffic developing. We shall note first the relation of the lumber industry of this region to its present markets.

Northern European saw mills are primarily interested in nearby markets. The surplus lumber producing regions of northern Europe are Sweden, Finland, and Norway; the countries deficient in timber resources are Great Britain, Germany, and France. At the present time, however, the northern lumber regions, despite the fact that timber is one of the principal industries of Sweden and Finland, are supplying only one-half the timber and lumber requirements of the importing coun-

tries.[24] For the remainder of their imports Great Britain, France, and Germany must depend on Russia, other European countries, and North America. Looking toward the future, then, it must be obvious that the surplus lumber regions of northern Europe will seek to expand their sales in nearby consuming territory, where their competitive advantages are greatest, before they endeavor to build up an extensive trade in distant markets. This is the first factor to be considered in connection with the St. Lawrence. In the second place the question of lumber specifications has a bearing on the problem.

European lumber does not meet American requirements as to sizes. The European lumber mills cut their stock on odd sizes; 5, 7, 9, and 11 inch widths. American lumber ordinarily runs 6, 8, 10, 12 inches in width. For Swedish or Finnish lumber producers to develop a market in this country, therefore, they would have to adjust their mills for producing American specifications or they would have to build up a market in this country for European sizes. Either adjustment might be made were these northern European producers forced to seek American or other remote markets to dispose of their output. Since they are supplying only a part of their nearest and best markets, however, it does not seem advisable for them to adapt their sizes to American requirements.

We conclude, therefore, that under normal conditions, northern European lumber producers would not be interested in

[24] This is a rough approximation based on 1924 data. Total consumption of timber and lumber products estimated at 11.4 million metric tons for Great Britain, Germany, France and the Netherlands (excluding imports into Great Britain valued at 17 million pounds which were not reported on a weight basis). Exports to these countries from Sweden, Finland, and Norway, amounted to 4.8 million metric tons (3.5 million feet B. M.) of sawed lumber, and 760,000 metric tons (69 million cubic feet) of round and hewn material.

Imports into Great Britain are taken from *Statistical Abstract for the U. K. 1910 to 1924.* All other figures are derived from *Commerce Yearbooks,* 1924 and 1925.

markets as remote as America.[25] It may be asked, however, whether northern European lumber might not enter Great Lakes markets during periods when nearby markets were depressed.

In answer to this question it may be said that the Atlantic seaboard cities would offer a much better market for intermittent shipments of European lumber than Great Lakes cities. The population of the seaboard is denser than that of the Middle West; the facilities for handling lumber are much better than could be had at Great Lakes ports;[26] and the regularity and frequencies of shipping existing between the east coast and Europe could not be duplicated between the Great Lakes and the Atlantic.

We see no reason, therefore, for anticipating the development of a lumber trade between the Great Lakes and northern Europe.

F. Lumber Exports from the Great Lakes Region as a Source of Traffic for the St. Lawrence

As has been brought out in our analysis thus far, the Great Lakes states are for the most part an importing region for timber and lumber products. In the case of hardwood flooring, however, their production is in excess of their local markets, and their surplus, principally maple, beech, and birch, is distributed to a wide range of markets. Hence, it has been suggested that they might export via the St. Lawrence.

A brief analysis of the trade, however, indicates that this industry is of no importance from the traffic angle. Exports of hardwood flooring of all classes of wood amount to less than 600 tons per month for the United States as a whole at the

[25] United States imports of softwood lumber from Finland, Norway, and Sweden totaled 2,783 M feet in 1924 and 2,354 M feet in 1925.

[26] We have already shown that Great Lakes cities would not develop a waterborne lumber trade in domestic woods and hence would not develop modern wharves and terminal yards.

present time.[27] And, any considerable expansion following the opening of the St. Lawrence is quite unlikely, since the product is of too high a grade to be handled in full cargoes and too specialized to depend on an infrequent transportation service. Quantities of this product which might conceivably use the St. Lawrence therefore would be negligible.

II. Pulpwood and Wood Pulp

The analysis in this and the following section is complicated by tariff considerations and other manifestations of national policy. Our trade in paper and paper-making materials is largely with Canada. Canada has sought to discourage the exportation of pulpwood and, in fact, beginning with Quebec in 1910, has prohibited the exportation of any wood cut from the crown lands, leaving only the relatively unimportant freehold lands (some 8 per cent of the total) as a source on which we can draw. The United States in turn has erected tariff barriers against Canadian exports of paper, except newsprint, which has been admitted free since 1911. The result has been that Canada, in her desire to use her unexcelled power facilities and cheap labor and to have at least a part in the conversion of her vast forest resources into paper, has exported to us increasing amounts of wood pulp and newsprint. There has, in fact, been agitation in Canada for the imposition of an embargo or export duty on pulpwood, an agitation not dissociated from the import duties we have placed on most paper products.

This situation is sketched only to show how difficult it is to predict what the future may see in the way of the erection of new or the removal of existing barriers to the flow of paper and paper materials across the international boundary. For the purpose of a traffic analysis we shall assume that present arrangements will continue unchanged during the period under study.

[27] Exports of hardwood flooring averaged 558 M feet per month for 1924; 589 M feet per month for 1925. Compiled from *Monthly Summary of Foreign Commerce*.

1. *Pulpwood.* Our imports of pulpwood have been as follows in recent years:

	Cords		Cords
1922	1,045,000	1925	1,483,000
1923	1,352,000	1926	1,384,000
1924	1,264,000	1927	1,597,000

At 2,500 pounds to the cord, these imports have averaged 1,692,500 tons per annum in the years indicated. With very minor exceptions, all have come from Canada. The movement is very generally north and south rather than east and west. Fully 80 per cent of our recent imports moved into the upper New England states, into New York and, to some extent, into Pennsylvania. Of this by far the greater part moves in by rail, with perhaps 8 to 10 per cent moving directly across on the rivers (St. Croix, Penobscot, Kennebec, etc.) up the St. Lawrence to New York points, or around to Portland, Maine. Examination of railroad loading figures indicates that there are extensive local movements of pulpwood in the states named, as well as the aforementioned movement from across the boundary. There is considerable movement of domestic and imported pulpwood on the Great Lakes. Erie, Pennsylvania, receives large shipments, as do Detroit (River Rouge), Port Huron, and Muskegon, Michigan. A considerable amount is moved by barge or raft on Lake Superior and Lake Michigan. Buffalo and Tonawanda, at the other end of the Lakes, appear to receive smaller amounts from down the St. Lawrence. Some pulpwood moves into Michigan, Ohio, and Indiana by rail and some moves by rail from the north into Minnesota, Wisconsin, and other border states.

Under these conditions, what would be the possibilities of moving pulpwood over the deepened St. Lawrence waterway? We might with propriety assume that our imports of pulpwood from the region of the St. Lawrence are destined to diminish in the future. We shall, however, make the very liberal assumption that they will continue at the 1925-1927 level. So

stated, it is clear that our question becomes largely that of determining what *diversion* of traffic the deepening of the St. Lawrence would cause. For use to be made of the St. Lawrence, pulpwood now moving into the adjacent New York and New England territory would have to move west to Michigan, Ohio, Indiana, etc.

Pulpwood consists simply of logs of small diameter cut from spruce, balsam, hemlock, fir, poplar, jack pine, etc. The logs are moved by team to river or railroad and thence to mill for conversion by various processes—mechanical or chemical—into wood pulp, or to some concentration point whence distribution is made to as wide an area as can be reached in competition with other sources of supply. Shipments by rail are relatively expensive and transfers between rail and water are costly; hence conditions most favor long distance movement of pulpwood when unbroken water transportation is possible. In the case of so low a grade of traffic, time is not an essential factor. Storage is extensively practiced, and usually two years elapse between cutting and pulping.

The possibilities of using the St. Lawrence can be examined under the most favorable conditions if Michigan mills are taken as the destination points. for to these the haul by vessel would be longest. The mills working up the pulpwood are nearly all situated in cities on the Lakes, such as Detroit and Port Huron. To reach them by boat from points on or beyond the St. Lawrence waterway would necessitate a river or rail haul to points of embarkation, movement to the Michigan ports, and, depending on the type of boat used and location of mill within the port, delivery direct by boat, or transfer and delivery by rail or truck.

Where a rail or truck haul would be necessary there could be little, if any, saving over a direct rail haul to mill. On the other hand, the larger type of boat for whose accommodation improvement of the St. Lawrence is proposed would, assuming it carried pulpwood at all, clearly not deliver it direct to mill door, but would discharge it along with the rest of its cargo at

public terminal. It follows, therefore, that the conditions for use of the St. Lawrence for delivery to Michigan mills would differ in no way from what they are at present. Small boats of the type which would make delivery direct to the mills, where this is physically possible, can now move over the waterway to Michigan points. The fact that little or no traffic of this sort has developed from River points indicates that basic conditions do not favor such movements. The reason is the availability of pulpwood in nearer sources of supply both in the United States and Canada, particularly Ontario. Second growth timber will also be available locally to some extent and it is expected by some who have followed the pulpwood situation carefully that the vast stands of timber in northern Montana and the Inland Empire generally will, in a very few years, begin to be called upon for pulpwood purposes. A low rail rate to Wisconsin, Minnesota, and Michigan mills would doubtless develop a great volume of traffic of this character. The distance even to Michigan points would not be greatly in excess of that from the region from which pulpwood would have to come if use were to be made of the St. Lawrence. Finally, much of the wood exported by Canada is cut at points which rigidly require an all-rail movement to nearby American points. In short, movements of eastern Canada wood into Middle Western states are altogether likely to continue to be in the form of wood pulp. There might, of course, be small, irregular movements into the Lake states, principally as back loading. The unpredictable character of such movements, their minor importance, and the fact that they would for the most part represent a diversion from Eastern states, makes unnecessary the setting down of a tonnage figure.

What significance has the fact that in 1925, for instance, some 750,000 tons of pulpwood were shipped on the St. Lawrence River on hauls of varying length? If this amount should continue to use the River after the deepening of the channel permits the operation of larger vessels, should credit for it be given to the deepened waterway? This question in other

forms has been presented to us a number of times and we have generally, except where the traffic was of an extremely short haul character,[28] given full credit to the route. Practically all of the above 750,000 tons is, however, short-haul traffic which could not use deep-draft vessels. Since no change in methods of shipment would occur on such traffic, no credit could be given the deepened waterway.

As for European pulpwood, it is hardly conceivable that any would move so long a distance in competition with supplies procurable nearer at hand or with wood pulp of either American, Canadian, or other foreign origin. A little might occasionally come in as distress cargo.

As for exports, our own are of small extent and represent almost wholly short-distance movements across the border. No use of the St. Lawrence is indicated. Canada exports no pulpwood to countries other than the United States.

2. *Wood pulp.* In this analysis we shall distinguish but two classes of wood pulp: mechanical and chemical. The one is of relatively low value, is shipped with a high moisture content, and cannot be stored for long; the other is of higher value, is shipped dry, and does not deteriorate as does the other in storage. Chemical pulp is classed as sulphite or sulphate. Our imports of sulphite pulp are increasing more rapidly than domestic production, while the reverse is true of sulphate, perhaps owing to the great expansion of its production in the South.

Our total imports of pulp have been as follows in recent years:

Year	Short tons	Year	Short tons
1922	1,124,072	1925	1,665,992
1923	1,228,982	1926	1,735,732
1924	1,525,440	1927	1,679,518

The increase is notable and is a reflection of the rapid expansion of our consumption of paper and the relative exhaustion

[28] See analysis of sand, gravel, and crushed stone.

of our stands of suitable pulping timber in the regions in which the paper industry is concentrated.

Canada is our most important single source of supply of wood pulp, though large amounts of chemical pulp come from other countries, as witness the following figures for 1927:

	Short tons
Mechanical wood pulp:	
Canada	230,681
Europe (Norway, Sweden, Finland, United Kingdom, etc.)	14,918
Total	245,599
Chemical wood pulp:	
Canada	548,318
Europe (especially Sweden, Norway, Finland and Germany)	881,851
Total	1,430,169
Other pulp	3,750
Grand total	1,679,518

How, next, does this pulp move into the country? That coming from Canada comes almost wholly all-rail, the only exceptions being small movements to four or five cities on the west shore of Lake Michigan, presumably for the most part on short hauls from western Ontario, and some moving on short hauls to Ogdensburg, N. Y. This fact is at first sight rather surprising. The answer is found in service and rate considerations. Paper mills now require regular and certain deliveries on their incoming pulp. They operate on a hand-to-mouth basis, often carrying only two or three days' supply of pulp and depending on daily receipts to keep them going.[29] Pulp from Canada and from such domestic pulp centers as Berlin, New Hampshire, flows into the lake states in a remarkably steady stream. On

[29] A little more is carried in the winter months.

much of this traffic the so-called differential rail lines are available, giving rates two or three cents a hundred under the standard rail rate.

There appears to be no possibility that the deepening of the St. Lawrence will work any significant change in the routing of wood pulp. In practically every case an originating haul (rail, boat, or otherwise) would be required to get the pulp to shipside, with a transfer there, then a water haul of no great length and, in most cases, another transfer and rail haul to destination. So far as savings go, it is doubtful whether they would be recognizable. To make use of the waterway would also require storage both at pulp mill and paper mill, and in every respect the quality of service would be below that furnished by the rail carriers. The industry will not forego the advantages of the present regular flow of pulp from pulp mill to paper mill (usually a matter of contract requiring stipulated deliveries) unless there is a substantial saving to be had from using the alternative routing. Such saving there could not be in this case.

Support for this conclusion is found in the slight use made of lake shipping service today. Buffalo, which would be a convenient assembling point for shipments west from both Canadian and American mills, has not sent out, so far as available records show, a ton of pulp in recent years. The cost of transshipment, delays, and irregularities tell the story. Nor is there reason to anticipate that the situation would be different if deepdraft vessels could navigate the St. Lawrence channel. There is plenty of vessel service today; construction of the deep waterway would not articulate it better with the needs of the paper industry.

What, however, of foreign pulp? Surely, it will be said, this would move in directly. Here buying is not direct but through dealers with headquarters in coast cities. This pulp is brought in via Baltimore (sometimes Philadelphia, Norfolk, etc.) and distributed from there at a rate as low as 32 cents to a point

such as Kalamazoo. New York and Boston also are ports of entry. In some instances rail-lake-rail routes are used. For the most part, the dealer takes up the irregularities consequent upon the receiving of large shipments from abroad. In the past few years a little Scandinavian pulp has moved direct to lake ports in the small vessels which can navigate the present St. Lawrence channel.

Let us see what would be involved in moving foreign pulp over the St. Lawrence. There are two possibilities: that the interior mills, or a group of such mills, would import in their own name, or that the established importers would assume responsibility but direct that delivery be made at such lake ports as were deemed convenient. Transportation costs alone considered, there should be a saving in such routing, though how great it would be is difficult to say. Certainly the ocean rate to Baltimore and other such ports would normally be less than that into the Lakes, in view of relative distances, character of navigation, closed season, and smaller total volume of business from this trade region. Uncommonly low ocean rates are accorded pulp laid down at these secondary North Atlantic ports. The number of transfers would be the same in reaching inland points and one less in the case of mills at lake ports, while the long rail haul from the coast would be replaced with a relatively short one from lake ports or be dispensed with entirely in some cases. However, there would be the trucking or switching charge from public dock to mill in the case of plants directly at lake ports, and this, as we have seen in other connections, is an item of very considerable importance. The greater number of converting mills in a state like Michigan are at inland points. The net saving in total of transportation charges alone could not, then, be a strikingly large one. What other considerations enter into the calculation?

There is first the question whether American paper mills would undertake to order directly, whether individually or in groups, as by states. If this ordering should be done individually, rather large quantities would have to be ordered at a

time, which would require looking a considerable distance ahead and dovetailing purchases made in other quarters so as to avoid either over- or under-stocking. Storage facilities would have to be provided and a certain tying up of working capital incurred. On the other hand, if a number of mills banded together and purchased, let us say, a cargo at a time or a substantial volume for liner shipment, there would be the expense of looking ahead, as in the case above, and also that of accepting deliveries at one or more lake ports for dispatch to individual mills. The latter job, which would require some designated agency for the purpose, is, of course, one of the principal functions of the importer from whom the mills now buy.

There is also the factor of the closed season to consider. A prominent traffic expert of the industry estimates that from a fourth to a third of the industry's pulp requirements would have to be assembled just before the closing of navigation. This, he states, "would not appeal to the user of foreign pulp . . . because the tonnage that will be required for so long a period would be quite impossible to forecast. This is so because the market for paper made from imported pulp is altogether too uncertain." In addition, of course, there would be the expense of storage on an uncommonly large scale and of tying up a considerable amount of capital. Some gain or loss might also result from changes in the prevailing price between the date of execution of the contract and that of use of the last of the shipment.

These considerations clearly suggest that the individual converting mill, which, after all, is typically not a large affair, will not go to the trouble and expense of importing directly. It might experiment with doing so from time to time, but would be likely to shift these responsibilities on to other shoulders upon finding the net advantage, if any, too slight to warrant giving the necessary energy and attention to it.

Would the situation be different in case the mills banded together? This one matter would not in itself be important enough to warrant the establishment of an organization to

receive and place orders and receive and distribute shipments. Clay (kaolin) also is imported in large amounts from Europe for use in the paper industry, but, as our analysis of that commodity indicates, it comes in and is marketed under such conditions as to preclude any large use of the St. Lawrence route. Aside from the expense that would be involved, there is always the difficulty of getting united action. As pointed out on occasion before, experience indicates that joint action on such a matter as this is almost impossible to obtain. Business houses, whether competitors or not, like to act individually and without commitments of any sort. And so we cannot foresee that pulp would be brought into the Lakes by paper manufacturers acting collectively.

To exhaust all the possibilities, we may ask whether importing houses would not develop at the principal Lake ports, perhaps with branches at other Lake ports; or whether the importers having headquarters at ocean ports and operating mainly from there might not establish summer branches on the Lakes or at least direct that movement into the Lakes rather than to ocean ports, as at present.

As to the first possibility: It is difficult to see how, with the slight margin of advantage we have found in the St. Lawrence route over use of an ocean port, there could be profit enough, together with the relatively small volume of business, to enable import houses to operate from Great Lakes ports. They would have to store enormously to have supplies to carry their customers over the winter months or else operate only during the season of lake navigation. They would also be limited in the range of territory they could reach. We can see little possibility of such houses maintaining themselves against the competition of those operating from the coast.

The second possibility suggested above raises a very important problem in economical business practice. Were the saving to be had as the result of use of the St. Lawrence route a large one, business organization would quickly adapt itself

in either of the ways indicated. But, as pointed out before, the net saving would not be large in any case. Hence it is likely that the big importers would continue to find it to their advantage to bring in large lots of pulp at one of the ocean ports and distribute it in all directions on the low rail rates with which they are favored. To do otherwise would require the maintenance of a staff and storage facilities at one or more Lake ports and would also result in some subtraction from the efficiency of present arrangements.

Our conclusion, that no pulp would flow in over the St. Lawrence route, appears to fly in the face of all reasonable expectations. Surely, it will be said, with Norwegian vessels now bringing in some pulp and with the Scandinavian Peninsula and that general region able to supply us with pulp produced under low-cost conditions, the direct route into the Lakes would be extensively used. The price of the foreign product really does not enter into the question of how deliveries on it are made, and the Norwegian vessels which have reached the Lakes today were largely driven into such unprofitable traffic because of the depressed condition of ocean shipping generally. Pulp would never move into the Lakes in cargo lots; and liner service, if it becomes established at all between the Great Lakes and the Baltic region, will be very much less frequent than that between the North Atlantic ports and that region. The closed season is a very serious handicap in the way of establishing regular trade relationships of the kind that would be necessary if a large use were to be made of the St. Lawrence route. There are also competitive sources of supply (especially eastern Canada and, a more recent development, a very extensive present and potential development in western Ontario) that put a limit on importations from abroad. Perhaps more significant than any other one fact is the fact that extremely few American paper mills (other than pulp mills) are situated directly on the Lakes. Study of the location of American and Canadian paper and pulp mills reveals a very extensive development in (1) New England, New York, and eastern Pennsylvania—all

regions out of the St. Lawrence zone; (2) a smaller development in southern Ohio and central eastern Indiana—again out of the St. Lawrence zone; (3) southwestern Michigan, almost entirely at inland points; (4) northeastern Wisconsin, in most cases at inland points. There is, of course, (5) the very great development of both pulp and paper mills in eastern Canada (particularly Quebec) in the vicinity of the St. Lawrence River. But in relatively few cases are these mills directly on that stream, and even where this is the case the significant factor is whether boats would put in at points in the vicinity of the mills or the pulp would have to be moved (by rail or water) to a place of some size where shipments could be gathered together for regular packet shipment. It will be found that mere location on water is of very little importance, except in those cases where the mills operate their own boats. So accustomed are American and Canadian pulp mills to a regular daily discharge of their production that holding supplies back or concentrating them for a stipulated boat at a particular point would scarcely appeal at all.[30]

It is our conclusion, then, that there would be no important, regular use of the St. Lawrence route for the movement into the Middle West of either Canadian or European wood pulp, much less American pulp originating in the New England region. Such a conclusion does not, however, mean that no use whatever would be made of the St. Lawrence route. There is a possibility that some pulp would move between shipping points on the St. Lawrence and important Lake ports at which paper mills are situated, if regular packet service became available. Even such movements would be incidental to a larger rail movement. Also it is possible that foreign wood pulp would occasionally be brought in at very low rates, possibly as

[30] Perhaps attention should be called to the fact that the railroads serving these mills are so peculiarly dependent on the industries—often they are the only industry on a given branch—that any diversion of traffic would have serious consequences on the service the mills could receive and rates they would have to pay on the traffic remaining.

distress cargo, particularly during the period of American grain exportation. Such shipments are absorbed somehow, though without special planning and generally at sacrifice prices. Though the question is a debatable one, it is our belief that traffic of so irregular a character does not belong in a traffic analysis of the kind we are making. It is not traffic which can stand on its own feet, nor is it traffic that can contribute to the support of the waterway undertaking.

Assuming that the deepening of the St. Lawrence would stimulate to some extent the use of packet service between river points and the Lakes, we may set down, in a purely tentative fashion, 50,000 tons as a liberal estimate of the annual movement of pulp that would be attributable to the route. This movement would be limited almost wholly to mills at Lake points which might be able to supply a part of their needs in this way, at some saving. Some would represent shipments in mill companies' own boats.

Our exports of wood pulp are not extensive, being about 34,000 tons in the years 1924 to 1925. Of these, Canada took three-fourths, the rest going to the United Kingdom and a scatter of countries. The movement into Canada is merely across the border. The bulk of the remainder of our exports pass out through Virginia ports, signifying production in that general region. The lake states, except for the small sales to Canada, are not exporters of pulp and no use of the St. Lawrence is indicated for such purpose.

Canada, however, has some exports to countries other than the United States that must be considered. These have been of mechanical and sulphite pulp and more largely the former. Such exports averaged 156,245 tons in the years 1923-1927. Nearly 60 per cent of these went to the United Kingdom. Some of this traffic must have originated in British Columbia, though probably not a great deal. Quebec doubtless originated the bulk of it, with perhaps small amounts coming from New Brunswick and Nova Scotia and eastern Ontario. For ship-

ment across seas, traffic of this character must be concentrated at convenient points and at not too many points. These points would be Montreal and Quebec, with perhaps some use of Toronto and Hamilton. But Montreal and Quebec are well served at the present time and are below the point at which the St. Lawrence route technically begins. British Columbia is certain to become of increasing importance in years to come, as is western Ontario. The latter, however, will be called upon to serve the large Mid-west market. Under the circumstances, assuming that some general cargo service from the head of the Lakes would develop and liner service from Toronto and Hamilton, we might estimate that as much as 20,000 tons of this traffic could find a foreign market in competition with that originating at points more favorably situated for export business.

In all, then, we find 70,000 tons of traffic in wood pulp, of which 50,000 tons is attributable to the United States and 20,000 tons to Canada.

3. *Rags and other paper stock.* At one time almost the sole material from which paper could be made, rags at present are of minor importance as a paper-making material, being used chiefly in the manufacture of expensive grades of paper—bond, ledger, fine writing papers, etc. Nevertheless, our imports are extensive, averaging 240,000 tons in 1925-1927 and showing a large increase over the average of 107,000 tons in the years 1912-1914. Over 85 per cent of our recent imports came from Europe, small amounts from Canada and Latin America, and considerable from the Far East, especially Japan.

The significant feature of this import movement is the extensive use made of our secondary ports. Philadelphia outranks New York; and Baltimore, Massachusetts ports, and Southern and Western gateways are used very considerably. The reason is, of course, that this is a very low grade of traffic which must have low rates to move long distances and which can put up with inferior transportation service. It is the kind of traffic that would seek a route such as the St. Lawrence,

though, as in the case of wood pulp, commercial considerations and the availability of low rail rates (from New Orleans, the Mississippi-Warrior River service also) will tend to cause the bulk of the imports to follow present routings. Also, there are mills using such stock in the vicinity of the ports named.

A considerable part of the manufacture of paper of the kind in which rags are used occurs in the so-called Kalamazoo Valley, though Massachusetts clearly leads and other Eastern states are important. The most liberal estimate would not place the production of this paper in the section adjacent to the Great Lakes at more than 35 per cent of the total, and most of this production takes place at points inland which would require a rail haul to plant door. Imported rags are most likely to be used in the vicinity of the ports of entry, with interior mills depending more largely on domestic rags. Only very minor direct entries are now credited to the interior customs districts.

If we take the average figure for 1925-1927, 240,000 tons, and raise it by 50 per cent to allow for expansion of imports in the next decade or so, we have some 360,000 tons of total imports to consider. Taking 35 per cent of this gives 126,000 tons, and if we make the liberal assumption that two-thirds would move during the season of navigation, we have 87,000 tons for further consideration. Our assumption that 35 per cent of the total imports of rags would move into the lake states is so distinctly liberal, however, and the commercial and other considerations alluded to above so important, that it seems proper to conclude that at best not more than one-fourth of the above 87,000 tons, or, in round numbers, 22,000 tons per annum, would enter via the St. Lawrence route.

Our exports of rags and other paper stock averaged 98,000 tons in 1925-1927. Our best markets are Canada and the Far East, which together account for about 90 per cent of our sales. The movement into Canada would be a rail movement almost entirely. For the Far East movement Los Angeles and San Francisco are very extensively used. It is altogether likely

that the great bulk of our exports will originate in the vicinity of our great ocean ports, and more especially in regions of cotton cloth manufacture. Small lots might occasionally be picked up at lake ports, but the volume of business would not warrant an extensive trade development. We may set down 2,500 tons per annum as a liberal figure under this head.

Canadian mills utilizing rag stock are found at and below Montreal, at Toronto, and at inland points in Ontario and Quebec. In some cases use of imports from the United States is indicated, while in others rail distribution from Montreal would occur. Canada's exports of rags have not been very extensive, other than those sent into the United States, of which a part at least represents re-exports. We might set down a total of 5,000 tons as representing the maximum Canadian use likely to be made of the St. Lawrence route, divided equally between exports and imports.

As a final paper-making material we may mention waste bagging, waste paper, old rope, etc. Of these we imported approximately 100,000 tons in recent years, of which the greatest part came from Europe, with Canada very important in the case of waste paper. The considerations entering into the routing of this traffic are much the same as those governing the movement of rag stock. Considerable fluctuation in price makes for sales in relatively small quantities. Raising the above 100,000 tons by 50 per cent to allow for growth, deducting no more than a third for movement during the closed season, assuming that a third would move into Wisconsin, Illinois, Indiana, etc., states where the lower grades of paper are produced, and that a fourth of the total imported paper there used could come in via the St. Lawrence, gives something over 8,000 tons of traffic per annum. This can be increased to 10,000 tons, a figure which would allow 2,000 for possible Canadian use of the waterway.

III. Paper

1. *Newsprint*. Standard newsprint is a low grade of paper used principally by our daily papers and incidentally in cata-

logues, telephone directories, scratch pads, etc. Our consumption of newsprint has grown enormously, while the partial exhaustion of our supplies of good pulping timber and the unusually favorable conditions for newsprint production in Canada have caused us to depend increasingly on imports, as the following figures show:

	Tons
1914	278,071
1918	596,517
1920	729,844
1922	1,029,293
1923	1,208,842
1924	1,357,233
1925	1,448,425
1926	1,850,675
1927	1,987,064

About 90 per cent of our imports are of Canadian origin, the remainder come from Scandinavian countries and Germany. Let us first examine the possibility of moving Canadian newsprint in via the St. Lawrence.

Certain unusual facts are essential to an understanding of the traffic problems of newsprint. First is the method of sale. Newsprint is sold on contract; it is not bought anywhere in the market from time to time. In fact, some of the big publishing houses make their own paper through subsidiary companies, with plants in Canada. The removal of the tariff on newsprint in 1911 facilitated this shift in the situs of the industry. Further, newsprint now moves with the greatest regularity from mill to press. In the case of the large newspapers, deliveries are made daily and the movement is commonly direct from car door to press room. A few days' emergency supply may be stored somewhere, but extensive storage at printing plant would be prohibitively costly. Opinions differ as to whether deterioration occurs after storage for a time. As few handlings as possible are desirable, as injuries to the edges may result. Stowage in freight car is a matter given careful consideration,

the rolls being carefully braced and other precautions taken to prevent injury or loss of the cylindrical shape that is so necessary to smooth press work. Direct and frequent rail movement also spells economy at the mill, for it saves handlings and storage there and keeps the output always up to schedule. Clearly, rail movements from mill to press room are the ideal way of handling newsprint; if any other method of transportation has a chance of competing it must be on the basis of some large saving in costs.

Certain tendencies in the movement of newsprint require noting. The great production of newsprint in Canada takes place in Quebec and eastern Ontario, with beginnings in New Brunswick and a considerable development in western Ontario in the general vicinity of Sault Ste. Marie and the Twin Cities. Distance of the "eastern blanket" (a large area embracing roughly northeastern New York, western Massachusetts and Connecticut, all of Vermont and most of New Hampshire and Maine, as well as the extreme eastern part of Ontario and lower Quebec) from the Midwest markets has made it difficult to compete with supplies nearer at hand; in fact, in 1925 these Eastern mills sent Chicago only 32,000 tons of newsprint as against 189,000 tons sent by Western mills, while in 1920 they sent 85,000 tons compared with 27,600 tons supplied by Western mills.[31] The Eastern mills are looking more and more to Eastern, Southern, and Southwestern markets, while the Western mills do not find it possible to ship east of Pittsburgh. There are some, in fact, who fear a shortage of newsprint in the Eastern market, leaving no surplus of Canadian production for the United States Middle West market. Pacific newsprint may be called upon to help supply the Eastern market. Our task, then, is that of determining whether the provision of a deepened St. Lawrence would enable a larger volume of shipments west from the "eastern blanket" and possibly from New

[31] E. M. Antrim, Exhibit No. 1 in I. C. C. Docket No. 18597, p. 20.

Brunswick, which is now unable to reach Midwestern points. No other movement of Canadian newsprint would be likely to present the possibility of use of the waterway.

The average distance from the " eastern blanket " to Chicago is 955 miles and the rate 38.5 cents per hundred, yielding therefore a ton-mile rate of slightly over eight mills. This will be recognized as an extremely low rail rate for merchandise freight. A comparable figure for lake transportation is very difficult to secure. However, we find a lake movement to Chicago in 1922 at 4.48 mills per ton-mile and shipments from Buffalo at rates of 12.252 and 6.376 mills per ton-mile.[32] The evidence is meager, but to be liberal, we will make our subsequent calculations on the basis of a water rate as low as four mills per ton-mile, or one-half the rail rate. This would give a rate of $4.98 cents per ton from Montreal to Chicago (a distance of 1,244 miles), compared with a rate of $7.70 all-rail, an apparent saving of $2.72 per ton. This saving, however, could not actually be realized for these reasons:

Use of the St. Lawrence for year around needs would require extensive storage both at mill and point of consumption. We may estimate the storage cost at 50 cents a ton a month, or, let us say on the average, $1.50 for the closed season. In addition, there would be interest on the money tied up. Taking the average price of newsprint in 1925, $70 per ton, we find interest per ton at 6 per cent for three months to be $1.05. Interest and storage alone equal $2.55, leaving a difference of but $0.17 between the two methods of shipping. Moreover there would be a serious disruption of production, making it necessary to run at low ebb, or to stop entirely in the case of some plants, during the winter months.[33] Without further refinement, we have, we think, demonstrated that

[32] From Part 2, Commercial Statistics, Annual *Report* of Chief of Engineers, U. S. Army.

[33] It might be argued that the mills would carry on production during the winter months in anticipation of the spring opening. But this would require extensive storage at mill and a tying up of money spent for materials and labor.

there could be no advantage in shipping a winter's supply for storage. Our example has, moreover, been one under which conditions would most favor use of the water route, for the cost of a possible rail haul and transfer to boat was not considered. More will be said about this presently.

Let us examine a different possibility: that during the season of navigation the boat lines (assuming a fairly frequent service, but scarcely better than weekly) would be used, and the rail lines the rest of the year. Here the disruption of mill production schedule would be less serious, though some storage and extra handling would be necessary. The greater interval between deliveries (which are daily by rail) would necessitate storage of the greater part of each boat's offerings (and this would be particularly true if boats were chartered for the exclusive use of the big publishing houses.) This could not be less, and probably would be more, than 50 cents per ton in and out of warehouse. There would also be the extra trucking haul, either to warehouse or to printing room, which could not, in our great congested centers, be less than five cents a hundred, or one dollar a ton.[34] There would be injuries due to extra handlings to consider, additional clerical work, etc. Of the apparent saving of $2.72 per ton, $1.15 might be left. But now let us examine into the cost of getting the paper to shipside and into the ship's hold.

In the case of all plants (except those shipping in cargo lots, of which more later) some form of movement to shipside would be necessary. This might be only a local switching movement in the case of plants situated at ports of call of the boats, or a line haul of varying length, depending on the exact location of the mill.[35] The switching at Sault Ste. Marie necessary to get shipments of newsprint under way for Chicago costs 49

[34] If the paper were left at dock, demurrage would rapidly mount up.

[35] It is possible that in some cases trucks could haul the paper to dock, but as such haulage is more expensive than switching, we need not consider it.

cents per ton; at International Mills the cost is 44 cents a ton; at Escanaba, from $1.10 to $1.40 per ton.[36] Depending, then, on local conditions, the switching charge might leave a small net saving or, in many cases, absorb the entire remaining difference between costs all-rail and via water.

We can see, then, little or no possibility of shipping newsprint alternately by boat in the summer and by rail in the winter. Everything points to a continued and almost complete reliance on rail service.[37]

Our general conclusion is, then, that the deepening of the St. Lawrence could be of no appreciable assistance in enabling newsprint manufactures in the " eastern blanket " and points beyond to regain their importance in the Central Western market.

Two additional points require consideration. It is to be noted that the examples we have used have taken Chicago as the destination point. What of the great numbers of cities at inland points or, for that matter, any points not important lake ports? The answer is obvious. A transfer back to rail from boat would prevent the use of the route. The combined lake and rail rates would be prohibitive, as would the handling and transfer charges.

But, as the last potentiality, it might be asked whether the large publishing houses would not operate their own boats and thereby effect a lower lake transportation cost and enough of a net saving to warrant use of the waterway. There are, of course, only a very few establishments large enough to do business in this way. Our earlier analysis proves, we believe, that storage against the winter's demand is out of the question, particularly as the result would be a very serious disruption of

[36] Derived from E. M. Antrim exhibit referred to above.

[37] We again must repeat that often rail lines find their sole source of traffic from certain shipping points in the paper mill trade. Anything that diverts traffic or lessens its " clock-like regularity " must mean increased rail rates on the remaining traffic or abandonment of service.

production. To ship in cargo lots the large publishing house would practically have to own its own boats. This would mean operation seven or eight months of the year and for the most part a one-way haul, both conditions that tell against profitable operation. Large amounts, four or five thousand tons, of paper would be deposited at a time, requiring movement into temporary storage. The largest publishing house, with a consumption in 1926 of about 8,000 tons of newsprint per month, could use two shiploads a month.

Though accurate prediction is difficult, it is our carefully considered conclusion that by the time all the collateral costs are brought into the picture there would not be enough saving (if any) to warrant the attention and dissipation of energy that would be required in the use of an irregular or infrequent service in place of the exceedingly smooth, almost automatic, inflow of newsprint enjoyed today. It is not unlikely that a great deal of experimenting would be done—and this should be done—to determine the possibilities of effecting savings by shipping newsprint in large quantities by water. But, unless the collateral costs were ignored, it is altogether likely that the result would be eventual abandonment of the effort. It is to be particularly noted that at any rate only the largest publishers in one or two Western lake cities could hope to gain by such experimentation.

Were sales not made on a contract basis and shipments sent direct to point of use it is conceivable that considerable use could be made of the water route. If, in other words, newsprint were bought and sold generally in spot supplies, the breaking up of large shipments, storage, etc., would be necessary whatever the method of haul. But sales are most effectively made on a contract basis and doubtless this will continue to be the case.

We have not yet considered the possibility of non-Canadian newsprint entering via the St. Lawrence. Our imports from

the north European countries have been as follows in recent years:

	Tons
1923	193,000
1924	153,000
1925	131,000
1926	99,000
1927	121,000

The decline is noticeable. The reason is undoubtedly in large part the growing scarcity of newsprint in Europe. The effect of deepening the St. Lawrence is highly problematical in this case. Much would depend on the relative cost of production abroad and in Canada. With Canada so near and so abundantly able to meet our import requirements, it does not appear likely that a fully established, coördinated, and regular use would be made of these north European supplies. Owing also to the need for regularity of inflow and to the cost of storage and handling and extra movements, as well as to the declining supply available for exportation, it seems fair to predict that no appreciable volume of newsprint would come in. Europe rather is likely in the near future to be on an import basis. Newsprint therefore is unlikely to figure as an item of traffic, except perhaps a very few irregular shipments of a distress character. No tonnage figure is called for.

Our exports of newsprint are of negligible importance, averaging some 18,000 tons in the years 1924 to 1927. These have gone mostly to Latin America and the Far East and continued use of Eastern, Gulf and Pacific ports is indicated. The interior of the United States can not be considered an exporting region for newsprint.

What, finally, of Canada's exports to countries other than the United States? These averaged some 74,000 tons in the years 1923-1927. They are likely to increase rapidly, however, as the European demand increases. Some of these exports were made by the fast developing industry in British Columbia,

and the bulk of the rest, in view of the preponderant importance of Quebec and the inland location of most of the Ontario mills, would be concentrated at Montreal or some point below Montreal for shipment. It may be surmised that in time to come some exports might originate in central and western Ontario at points from which boat shipments would be feasible. Under the circumstances, an allowance of 50,000 tons of potential traffic would appear to be liberal.

Canada of course imports no newsprint, except negligible amounts on short hauls across the border.

2. *Other low value paper.* Under this head may be grouped wrapping paper, pulpboard and other paper boards, and hanging paper (unprinted wall paper). Our total imports in 1926 were 64,000 tons, and in 1927, 44,000 tons. Canada has been practically our sole source of supply of pulpboard, but Germany, Finland, Sweden, etc., supply most of the remainder of our imports of the papers designated. Canada's sales in this country have been only nominal in the case of wrapping and hanging paper.

In 1926 and 1927 we imported approximately 33,000 tons of pulpboard from Canada. There is, however, a remarkable concentration of the routing of this paper into the United States, five-sixths passing through the Buffalo and one-sixth through the Michigan customs districts. Little or none finds its way on to the Lakes. Examination of Canadian points of production shows that nearly all are inland or at least not at points whence St. Lawrence vessel service could be easily reached, and more than half of them are in Ontario and therefore at points which would not require use of the St. Lawrence waterway. There is little reason to believe that any appreciable amounts of pulpboard would enter the Middle West via the St. Lawrence: the total haul is too short and the cost of transfers and delays too great to warrant any such method of shipment. Occasional shipments might be made between points like Quebec and Montreal and the important lake cities, dependent on the packet service that might become available there. If we

set down 5,000 tons under this head we should be distinctly liberal. Shipments into Eastern and Southern United States will continue to move all-rail.

Our imports of the remaining items named above have recently been at the rate of from 14,000 to 62,000 tons. New York is a large point of entry and much use is made of the secondary and even less important ocean ports. Production is very extensive in the Middle West, making extensive dependence on foreign supplies quite unlikely. There can be no doubt but that some of these commodities would find their way into the Great Lakes territory on the boats that might ply infrequently between that region and Baltic points. There is no reason to expect a large development and commercial and trade considerations will continue to dictate an extensive use of a wide range of ocean ports. If we should start with an assumed total importation of 75,000 tons per annum, exclude four-fifths as moving through ocean ports, and assume that one-half the remainder would use the water route, we should have 7,500 tons of traffic, apparently a liberal estimate of the use that could be made of the St. Lawrence waterway.

Our exports of this general class of product totalled 93,000 tons in 1924 and 78,000 tons in 1925. The surprising feature is, however, that Canada has taken 40 per cent of these, with 11 per cent going to Europe, 22 per cent to Latin America, and 26 per cent to the Far East and Africa.

Paper manufacturers of the American Middle West do not at present enter seriously into the exportation of these products, and growing production in the South may force the Middle West manufacturer into other lines. The adjacent markets can absorb the available supply, and plants at other places are better situated for obtaining the foreign business. But this does not mean that, if better transportation facilities or lower rates were available, an effort would not be made to enter the more distant markets. What possibility is there of success in this direction?

A study of the location of these Middle Western mills shows that relatively little of the production is at the larger lake ports. The Ohio Valley and Indiana production would not look north, but east, for its outlet. Much of the production in Michigan and Wisconsin, though at lake ports, is not at ports that would be included in the itinerary of liner boats. A transshipment, either from boat or rail, to steamer would practically prohibit any use of the route, unless this break took place at a natural distributing center and represented a regular stage in the marketing process. Certainly no mill could directly engage in exporting unless able to go into it on a large scale and under the favorable circumstance of location at an important lake port. Under these conditions, no important use of the St. Lawrence waterway is indicated. Frequency of service would be low, dependability only fair, and the closed season would preclude the taking of contracts calling for deliveries throughout the year. It is also to be remembered that the movement into Canada would be very largely a direct movement north and would in most cases necessitate an all-rail movement. The paper mills developing (slowly, to be sure) in the South are going to be favorably situated for the Latin American business, and developments on the Pacific coast and in Alaska foretell a day when a large part of the trade with the Orient will be supplied from these Western sources.

In short, everything points to a restricted opportunity for Midwest manufacturers of low grade paper and paper products to engage in any important way in export trade (except with Canada), even if the St. Lawrence were deepened. There might be some, though small, opportunity for paper jobbers located in this region to make sales they do not find it possible to make today. Allowing liberally for growth of our total exports, we might set down 5,000 tons of traffic under this head.

Canadian export statistics under this head are for the most part given only in terms of value. Our estimates do not place Canada's present exports to countries other than the United

States at more than 30,000 tons per annum. As in the case of newsprint, conditions do not greatly favor use of the St. Lawrence for exports. Production is largely in Quebec and the east, is often at inland points, and rail or other inland hauls are almost always required to get the products to shipside. Concentration of Quebec and other eastern and of much of the Ontario exports at Montreal for the more frequent and reliable service available there seems altogether likely to continue, though some business doubtless would be done out of Toronto and perhaps from other Ontario ports. It would appear liberal to set down 5,000 tons as the maximum of such traffic likely to develop during the period under review.

Lastly, there are Canada's imports of low grade paper to consider. Of her imports of cardboard, millboard, etc., in the years 1924-1927, 97 per cent came from the United States; of wrapping paper, 77 per cent, leaving in these years an average of less than 600 tons to come from other sources; and 91 per cent of her hanging or wall papers. Movements from the United States have already been considered. Obviously, there could be no significant use of the St. Lawrence waterway for the small remaining items of imports brought into one of the world's greatest paper-producing countries.

3. *High and special grades of paper.* In this final group we have included not only writing, drawing and bond paper, but also printing paper (which does not fall conveniently under our other heads) and such special papers as tissue, cigarette, and photographic. A rather large group of "all other paper" has also been included, since unfortunately it is not possible to throw this under other heads. In all, our imports in 1925-1927 averaged about 25,000 tons, of which printing paper and "all other paper" made up over 70 per cent. Canada is almost completely out of the picture in this case. For the most part our imports have been from northern Europe, with France supplying us with practically all of the 5,000 tons of cigarette papers and books and the Far East being of some importance in the case of tissue paper, etc. New York is clearly the pre-

dominant port of entry, accounting for from 60 to 85 per cent of the entries. This fact is cited for the light it throws on the marketing process. On a very liberal estimate, a little over 3,000 tons of paper imports have in recent years been directly creditable to interior customs districts adjacent to the Lakes.

As in the case of so many other items representing high grade traffic, routing is dictated by trade considerations and relative costs of transportation are secondary. So in this case, our imports are likely to continue to move in largest quantity through New York and other ocean ports, where they are broken up into small lots and sent where and when the demand arises. The big department stores and mail-order houses in the Middle West (practically Chicago alone) might be able to make some use of the waterway and, irregularly, a paper jobber there might pick up supplies abroad for delivery direct into the Lakes. The great bulk of the traffic would continue to use present routings, however. Certain types of paper are used solely in other sections of the country, as, for example, cigarette paper and, to a large extent, photographic paper, and certain paper comes in in such small unit quantities as not to make direct importation via the St. Lawrence worth the trouble to which it would put the interior importer. For these reasons it is our belief that not more than 2,500 tons per annum would move in over the St. Lawrence route and this only under the special conditions noted.

Our exports of paper under this general head are extremely varied in character. Including "other paper and paper products," they amounted to about 95,000 tons in 1926 and 93,000 tons in 1927. Our largest single market in 1927 was Canada, which took 40 per cent, while the Far East and Africa took 21 per cent, Latin America 28 per cent, and Europe the remaining 11 per cent.

For a number of reasons, it does not appear likely that any significant use would be made of the St. Lawrence for these exports. For one thing, this type of traffic requires the best of service; delays in getting shipments under way are serious

handicaps to getting business away from more favorably situated competitors. Particularly handicapped in the matter of service would be the Middle West in this case with 70 per cent of the business going to Latin America and the Far East. In fact, as has been pointed out before, the Middle West has not been an important exporter of paper, partly because of her natural handicaps and partly because of the large domestic market near at hand. Some of the exported grades of paper are not produced in significant quantities in the Middle West. With a rail haul to lake port necessary in many cases, any apparent saving there might be in using the route would be seriously reduced. There is also the closed season handicap, making it difficult for either mill or jobber to establish lasting foreign connections. There is also the very important fact that orders are small and deliveries frequent in this line of export. Frequently also the routing is directed by the agency representing the foreign purchaser, which would tend to concentrate these purchases, along with others, at a central point, such as New York. Growth of mills in the South and on the Pacific coast also indicates that a larger part of our Latin American and Far Eastern sales will be taken care of from those regions.

In short, we do not see how more than the most irregular, occasional, and limited use could be made of the St. Lawrence route for exports of our better and special grades of paper. It almost goes without saying that movements into Canada would continue, with only slight exceptions, to use all-rail routings. The slight use now made of Great Lakes packet service for transporting paper testifies to the need for quick, certain, and regular deliveries in almost all cases.

Canada's exports of the higher grades of paper are extremely small. Her exports of bond and writing and book paper together averaged only 1,200 tons in the years 1922-1925, and there is a miscellaneous class of exports of unknown volume. This last, however, passes mostly into the United States. For all practical purposes, there is nothing here that could make

more than the most limited and irregular use of such liner service as might be available on the St. Lawrence route.

Canada's imports of these grades of paper also are limited. Book paper constitutes the largest item, of which on the average 2,834 tons were imported in the years 1922-1925, but of this all but 560 tons came from the United States. A slightly larger proportion came from abroad in the years 1924 and 1925 alone. The indications are that Montreal would continue to account for the greater part of these imports and that only insignificant amounts might irregularly find their way directly to ports further in the interior.

4. *Domestic movements of paper and paper materials.* What possibility is there of using the St. Lawrence in moving either paper or the raw materials from which it is made between domestic points in the United States and in Canada? Let us first eliminate all movements that obviously could not take place.

a. Pulpwood could not move over the St. Lawrence from interior United States points to coast points or from coast points to interior points. The interior has no surplus, nor have the coast regions, except the Pacific, and this is too far away and would require too circuitous a delivery for the movement of so low grade a commodity as this. The wide distribution of stands of timber renders any movement of pulpwood between the various regions of Canada out of the question.

b. Woodpulp would not move from interior United States points to coast points, if for no other reason than that there is no surplus to spare. Conversely, there is no reason to expect Eastern, Southern, or Western pulp to move around into the Lakes, since again a disposable supply is lacking and the movement would be extremely roundabout and unpropitious. Canada presents a picture of large manufacturing units making pulp and paper as one process. At any rate, Canadian regions (Quebec, New Brunswick, Ontario east and west, and British Columbia) are self-sufficing or only to a small degree interdependent. No significant use of the St. Lawrence for interterritorial exchanges is indicated.

c. Rags and waste paper, a very low grade of traffic, might conceivably move in small volume between Atlantic coast points and the Lakes if a packet service developed, but the necessity of transshipments to reach the mills, the extensive use of supplies nearer at hand, etc., practically exclude any significant volume of traffic of this sort. We will, however, set down 5,000 tons per annum, to consist of irregular shipments at very low rates. Canada might be credited with one-fifth and the United States with four-fifths of such a traffic movement.

d. Newsprint of course would not move in either direction between the Lakes and our coasts. There is no production on the coast (except on the upper Pacific) and the Middle West is an importing, not an exporting, area. Likewise in Canada, production is so widespread that it is difficult to foresee any regular use of the waterway for internal shipments. Had there been such possibilities they would have shown themselves in use of the service available today.

The sole movement we shall need to consider at length is that of paper (other than newsprint) and paper products, and the only movement of these commodities permitted by our physical or trade geography would be that between the Great Lakes and the coasts. Certain facts require immediate noting in this connection. One is the long-established production of all kinds of paper in the East and the growing production in the South and on the Pacific coast. Hence there are serious limitations on an interchange of traffic, for we appear to be developing in the direction of a greater degree of self-sufficiency in the various paper-consuming regions of the United States.

Also having a bearing on the situation is the kind of service required. With one exception, noted presently, the need is for swift, certain, and regular service. Traffic representatives of mills and jobbing houses have stated in unmistakable terms that they cannot use any service less than the best. A large Middle Western manufacturer and a jobber there have informed us of their inability to use the type of service available on the Mississippi-Warrior River barge line. The reasons are

delays in getting shipments under way, delays in transit, and the necessity of transfers. The business is highly competitive and exacting in its requirements. It is our belief, for which evidence is submitted elsewhere, that packet service between the Lakes and our various coast regions would be quite infrequent and limited at best to only a few principal lake and coast points. Nor is it our belief that such service could be conducted profitably at rates greatly below rail rates, probably not at rates much lower than would be required to offset the better service available via rail routes. Thus, though it is true that a considerable amount of paper has passed between our coasts in recent years,[38] there is no proof in this that paper would move from the lake region via water. Of the 72,645 tons which moved in 1924 an extremely small amount originated in the lake territory (except for movements out through New Orleans) and probably little or none of the Pacific coast paper found its way very far inland. This large movement of paper is therefore in great part a port-to-port movement to jobbers on the coast, and, additionally, has taken place under the unusually low rates which have prevailed during the rate wars in the intercoastal trade, with its particular lack of tonnage westbound.

Owing, then, to the infrequency of vessel service between the Lakes and the coast (assuming that such service would develop at all), and owing also to the type of service required on most shipments from Midwest mills and on shipments made by jobbers in that territory, it would appear altogether unlikely that any but the most irregular or occasional use would be made of the St. Lawrence route by such shippers. Certain further advantages of rail shipment reënforce this conclusion. Thus any size of shipment can be taken, whereas small shipments are not effectively handled by vessel lines. The shipper can also "scatter" a car of paper and yet get the carload rate.

[38] An average of 97,000 tons in the years ended June 30, 1927, and 1928.

Thus of a shipment weighing 36,000 pounds, 18,000 pounds might be dropped off at San Francisco, 9,000 at Los Angeles, and 9,000 somewhere else. This concession made recently by the rail carriers is of decided advantage to all shippers.

The answer is not so clear in the case of shipments to jobbers or manufacturers' agents. These can move more deliberately, since they would for the most part be for stock. At the present time the all-rail rate on carload shipments from a point like Kalamazoo to the Pacific coast is $1.33 a hundred. The combination rate via New York is about $1.02, of which 43½ cents represents the rail rate to New York, 3½ cents handling there, 50 cents the water rate, and 5 cents dockage at the other end. To this must be added the cost of delivery from dock to warehouse, doubtless close to 10 cents a hundred on this type of traffic. Insurance would be a small additional offset. There might be, however, a saving of 20 cents a hundred. What might the saving be if shipments were made direct from the Lakes? The water rate, in our opinion, would have to be very considerably higher than that from New York—at least double; but, to be liberal, we will put it at 80 cents. There would also be the rail haul to lake port and handling there, not less, in most cases, than 25 cents a hundred. By the time handling at the end is added on, also insurance and other minor costs, the total could not be less than $1.20, or, let us say, 13 cents under the all-rail rate. Some paper might move under these conditions and, of course, in the case of production at or near the ports of call on the Great Lakes there would be no rail haul but only a trucking haul. As additional offsets to what savings there might be would be the cost of maintaining agencies and warehouses in the coast cities and also the cost of storing and carrying supplies to last over the closed season. It is our best judgment that about the only orderly shipments to the Pacific Coast from the Lakes would be to established jobbers and that these would be only a part of the total yearly shipments even to such jobbers. Paper is of too many kinds and qualities to be carried in large quantities; shipments must be fairly fre-

quent even to jobbers and only in the case of certain much used standard papers could a large stocking up be profitable.

Our general conclusion is, then, that possibly 20,000 tons of paper could move to the Pacific Coast jobbers, while, to quote a well-known traffic man, " the rank and file would be compelled to use the all-rail routes in order to meet the competition of mills located in seaboard territory, East, South, and West." No significant movement to our Atlantic coast can be foreseen, so slight would be any savings under the best of conditions, while to the Gulf the route would be altogether out of the picture.

Traffic requirements in Canada are much the same as those in this country. Rail movement is therefore indicated for the bulk of the paper shipments, particularly as an originating rail movement would be necessary in a majority of cases. Interchanges between eastern Ontario and the head of the Lakes could not, of course, be credited to the St. Lawrence route, and apparently little goes by water between those points anyway. Shipments from eastern Canada for points in Manitoba, Saskatchewan, and Alberta could hardly be broken up into three parts—an originating haul of some sort, a lake haul, and again a rail haul. Shipments between the east and west coasts now have not only rail service available but the Canadian intercoastal merchant service. Trade requirements, geographic conditions and locations with respect to the route combine in narrowing the opportunity of using the St. Lawrence route, properly defined, for shipments of paper between regions in Canada. The spread of paper manufacture in Canada in recent years also tells against such movements. Furthermore, the only likely point to which shipments could go would be the head of the Lakes, to which region the bulk of the vessel movement would be tramp rather than packet or liner. In all, therefore, it is difficult to see how any significant amount of such paper could be included in this survey of the traffic potentialities of the St. Lawrence waterway.

APPENDIX E

IRON AND STEEL AND MANUFACTURES THEREOF

I. Iron and Steel

The analysis of this important class of traffic will follow a natural line of progression from the ore, through the semi-finished stage, to the finished iron and steel ready for the trade. The American movements will be followed through first and then the Canadian. In all there are 18 movements to be traced.

1. *Exports of American iron ore.* Exports of iron ore have always been a negligible item in comparison with the domestic traffic in that commodity. During the five years 1910-1914, our exports averaged 868,000 long tons and in the period 1923-1927, 822,000 long tons. Practically all of this ore went to Canada. Whether, therefore, exports of iron ore are likely to furnish traffic for the St. Lawrence route turns largely upon where in Canada the blast furnaces are found.

With the exception of furnaces situated in Nova Scotia, which has its iron ore near at hand in Newfoundland, practically none of the blast furnaces are found in territory that would permit of use of the St. Lawrence route. Quebec has little blast furnace capacity and all of Ontario's furnaces are at lake ports, on Georgian Bay, or at Sault Ste. Marie. Lake Superior ore goes to Sault Ste. Marie, Point Edward, and Port Colborne, but none of these movements could be attributed to the St. Lawrence route. No ore appears to reach Montreal via the present St. Lawrence facilities.[1]

If Canada is unlikely to draw American iron ores over the St. Lawrence route, what other export market for American

[1] The question whether Quebec or Ontario would bring in Newfoundland ores over the St. Lawrence is studied later in considering Canadian movements of ore.

ores is there? What of the argument that cheapened transportation will enable them to go to places which they never have reached before? Germany and France and the countries adjacent thereto can be eliminated as having supplies at hand. England would therefore be our chief potential market. But England would draw from the cheapest source of supply. At present she uses Spanish and Swedish ores extensively and is likely to draw, in a large way in the future, on Brazil. So long as England is a coal exporting country, freights on ore from both Spain and Brazil will be relatively low. The fact that Newfoundland has very extensive deposits of ore, little developed as yet and scarcely drawn on by England so far, indicates that England, if she looks to the North American continent at all for iron ores, will find them there, nearer at hand and accessible practically the year round, rather than in the more distant Lake Superior district, inaccessible for a large part of the year.

We conclude, then, that iron ore for export will not use the St. Lawrence route.

2. *Imports of iron ores.* Probably no one will argue that foreign ores would find a market in the Middle West were the St. Lawrence route open, but to make our analysis of probable traffic in iron and steel complete, brief consideration may be given to the possibility of such a movement.

So far as European, Cuban, and South American ores are concerned, it is apparent that the handicap of distance alone would exclude all except such special ores as are not available in our own rich and easily worked deposits. Would Newfoundland ores, however, be able to enter into competition with Lake Superior ores? The highly efficient production and transportation methods used by our large steel companies, combined with the advantages which come from their ownership of the mine properties, an ownership unlikely to be granted them in Newfoundland deposits, appear conclusive in establishing the unlikelihood of Newfoundland ores penetrating into the very center of the marketing area tributary to our own mines. Were

Lake Superior ores likely to be exhausted in the near future, such a movement might be possible, but there is general agreement that these deposits have a life which will run for a very considerable period into the future.[2]

3. *Shipment of Lake Superior iron ores to eastern blast furnaces.* A study of the distribution of Lake Superior iron ores shows that only a very small part of the movement reaches points east of Pittsburgh and Buffalo. There is, in fact, not a vast amount of blast furnace capacity on or near the Eastern coast. The developments in the Bethlehem district, Pennsylvania, and at Baltimore, are the most important. The eastern Pennsylvania plants were for the most part established in the early days of the iron industry in the United States and used local ores. This dependence on local ores has, in fact, continued down to date in the case of some of the districts. Thus the Harrisburg and Saxton districts in 1922 drew 183,000 tons of ore from local sources, 57,000 from the Lake Superior district, and 4,000 from foreign sources; in the case of the Reading and Lebanon districts these amounts were 43,000, 140,000, and 43,000, respectively.[3] These older plants, accustomed to supplying a local market, are unlikely to attempt expansion in the face of their stronger competitors, and at any rate the St. Lawrence route could not be used to any advantage what-

[2] It may be suggested, however, that a large user, such as the Ford Motor Company, with its own ocean-going boats, would bring in foreign ores. There is a speculative possibility of this taking place, but the extremely low costs achieved in using Lake Superior ores (both mines and boats being owned by the company), that a movement from abroad seems unlikely. Mr. Ford boasts that his "production cycle is about eighty-one hours from the mine to the finished machine in the freight car" (*Today and Tomorrow*, 1926, p. 115). The whole process of mining, transportation, and manufacture is geared together and speeded up in a most remarkable manner. Use of foreign ores, delivered irregularly, would upset all this, and such ores, delivered, would doubtless cost more than would the nearby domestic supplies.

[3] Some Lake Superior ore is required for mixing with foreign ores, but the ratio is small.

ever in supplying them with ore. The extremely circuitous water route, with a rail haul from Atlantic port, could not compete with a lake and rail haul via an Erie port. Our question becomes one of determining what use the Bethlehem Steel Corporation, with plants not only at Bethlehem and Sparrow's Point (Baltimore), but also at several other points in eastern Pennsylvania, at Johnstown, in the west central part of the state, and at Lackawanna (Buffalo), New York, would make of the St. Lawrence route.[4]

The Bethlehem Steel Corporation has extensive ore deposits in the Lake Superior region, in Chile, Cuba, and Mexico, as well as smaller ones in eastern Pennsylvania and northern New York. Its Lackawanna plant uses almost exclusively Lake Superior ores, its Pennsylvania plants local, Lake Superior, and imported ores, and its Sparrow's Point plant imported ores, with a small proportion of Lake Superior ores for mixing purposes. This company owns highly efficient ore boats plying to Cuban, South American, and other ports. It has, in fact, gone to such lengths to secure easily transported foreign ores on satisfactory terms as to suggest that, were Lake Superior ores available by an all-water route, an effort would be made to use them more extensively in its Eastern plants along with foreign ores. The question becomes, then, one of comparative costs of the domestic and foreign ores, laid down at the furnaces.

The determination of what these costs would be is obviously a highly speculative problem. Let us note some of its elements: (1) There is the cost of the ore at the mines. We have no information as to what these costs are, though it may be inferred, from the extensive use now being made of foreign ores and plans for an even greater use in the future, that the costs at

[4] It is rumored that the United States Steel Corporation will build a plant at Baltimore. There has recently been built a small furnace at Everett (Boston), Massachusetts, as well as one at Chester, on the Delaware River, Pennsylvania. Both plants are reported to have been built to use imported ores. At any rate, the analysis which follows applies also to them.

Lake Superior are not markedly, if any, lower than those elsewhere.

(2) There is the cost of transportation, which, in turn, presents three questions: (a) relative distances by different routes; (b) type of boat which could be used on the ocean-Great Lakes route compared with the highly efficient ocean-going vessels, as well as the very economical type of Lake boat, now used by this company; (c) the possibility of securing a return cargo.

When account is taken of the extent of restricted navigation, there is a disadvantage from the point of view of the time it would take to bring the ores from Lake Superior. Cuba, in fact, is nearer in miles. As to the type of boat, it is clear that sufficient depth of channel will not be provided in the St. Lawrence to accommodate the Bethlehem's present large ocean-going boats, particularly its combination ore-oil boat, whose loaded draft is 34 feet, 6 inches. To develop a boat capable of using the interior waterway would necessitate sacrificing the advantages of this type of boat as well as those of the lake type, and the result would be a boat that would have to be laid up in the winter months or used on an inefficient basis in the ocean-carrying trade.

As to the securing of return cargoes, it is to be noted that the ore from Chile and Cuba is brought in for the most part at New York rather than at Philadelphia, which is only slightly farther from the center of the Bethlehem's Pennsylvania production. Return cargoes probably are the determining factor. It would be more difficult to secure cargoes to carry back to the upper Great Lakes region, not only because of the limited volume of exchanges between this region and the coast, but also because such an arrangement would be of a seasonal character and therefore difficult to work out effectively. We must assume that only irregular, part cargoes would be available for shipment into the Lakes by boats of the type that would be used by the steel company.

(3) There is the effect of the seasonal closing of the route. Storage is extensively practiced in the steel industry, but it

entails a cost to be avoided if possible. (4) There is the possible effect on the Lackawanna (Buffalo) plant of the Bethlehem Company. This is possibly a minor factor, though a long-run view apparently would dictate the conserving of Lake Superior ores for manufacture at Buffalo and western Pennsylvania to meet the demands of the interior market, while using foreign ores for meeting the Eastern and export demand. It is, in fact, a matter of general knowledge that a large expansion of Sparrow's Point is planned, particularly with a view to supplying the export market.

It is our belief, based on a careful weighing of all the foregoing factors, that the Bethlehem Steel Corporation would continue to look mainly to the foreign fields for ore for its Eastern plants, because of its owning or holding under long-term leases cheap foreign sources of supply, because of its efficient ocean and lake ore carriers which could not be used in the combined Great Lakes-ocean trade, because the Great Lakes supply would involve winter storage costs, and because careful planning for the future would dictate saving the Lake Superior holdings of ore for the interior plants.

It remains to consider whether the Lake Superior ore required for mixing with foreign ores would be brought to Baltimore by boat. The total consumption of ore at the Baltimore plants of the Bethlehem Steel Corporation in 1927 was 1,168,-500 long tons. As already noted, the ratio of Lake Superior to foreign ore is very small, perhaps 5 per cent, which would make the requirements of Lake Superior ore about 58,000 long tons per annum. Having in mind the expansion of steel manufacturing in this region and looking ahead to 1940, it would be safe to assume that as much as 100,000 short tons a year of Lake Superior ore would be required for mixing purposes.

There are two alternative methods of bringing this ore from Lake Superior to Baltimore: by lake boat to Erie and thence by rail some 450 miles to Baltimore; or by boat down the Lakes to Erie and then a distance of roughly 2,500 statute miles around by the St. Lawrence and the Atlantic to Baltimore. By

the second route we have the advantage of avoiding transshipment at Erie ports, but the advantages of the efficient lake carrier would be sacrificed for the lake journey, and the water route is over five times as long as the rail haul. Moreover, if a boat were specially constructed for the carrying of this traffic, it might have to lie idle during the winter months—or at least be operated on a less remunerative basis. Traffic men who have studied the situation have expressed doubt whether any Lake Superior ore would come to Baltimore by water if the St. Lawrence route were open. In order, however, to give the water route the benefit of the doubt, we shall assume that 50,000 tons of ore required for mixing purposes would annually come from Lake Superior to Baltimore over the St. Lawrence route.

4. *Exports of pig iron and scrap iron.* Pig iron as such does not enter extensively into trade; rather is it the best practice to run the pig iron in its molten state directly into converters, a double saving of heat, compared with the use of commercial pig iron, being thereby effected. Pig iron for general sale is purchased more commonly by smaller steel plants or those making special steels, and by foundries for the making of iron castings. In the United States in recent years the pig iron entering into general trade has been not far from twenty-five per cent of the total amount of pig iron produced.

Of our pig iron entering into commercial channels not more than 2½ or 3 per cent commonly is exported. In actual amounts there were on the average about 182,500 long tons exported in the years 1910-1914. During the war period exports greatly increased, averaging about 414,000 tons in the years 1916-1920, but more recently they have been uncommonly low, averaging scarcely 37,000 tons in the years 1923-1927. For various reasons, it does not appear likely that our exports of pig iron will get back to the pre-war figure in the period before 1940.[5] We

[5] The increasing importance of alloy steels and the greater use made of scrap are two factors making for diminished dependence on pig iron.

shall assume, therefore, that perhaps double the 1921-1925 average, or 75,000 tons of pig iron, would move in export in about the year 1940. Some of this would represent special grades of iron, particularly that going to Europe.

When one inquires as to where our exports of pig iron go he finds that from three-fifths to three-fourths of them are sent to Canada. Of these, in turn, the greater part goes to Ontario, the center of the Canadian secondary iron and steel industry. Obviously, pig iron going to these plants would make no use of the St. Lawrence route. The movement would be up through Buffalo or across through Michigan. There are foundries and some rolling mills in the Province of Quebec, principally in or near Montreal and at Hull. Those at Montreal might make some use of the St. Lawrence route, contingent perhaps upon the development of a packet service between Montreal and the lake ports.

Our exports to countries other than Canada would, under the conditions named above, be at an average rate of 30,000 long tons per annum (two-fifths of 75,000 tons). A fraction of this might find its way out via the St. Lawrence, though any such exports originating in the Pittsburgh and other Eastern districts and in the South would, of course, pass through Atlantic and Gulf ports, respectively. A further deduction would have to be made for movements during the closed season and, in the case of shipments from Buffalo, for shipments via the Barge Canal. Under the circumstances, an allowance of 7,000 long tons per annum would appear to be liberal. This represents about 8,000 short tons, which figure will be raised to 12,000 tons to allow for minor shipments down to Montreal.

Scrap iron and steel is being increasingly used in iron and steel manufacture. Since it is somewhat akin to pig iron, a word may be said about it in this connection. Our exports of scrap averaged 118,000 long tons in the years 1923-1927, and of these probably one-half moved into Canada, with much of the remainder going to the Far East. Gulf and Pacific exports

are extensively used, Galveston particularly. This is a type of traffic that can use inferior transportation service and that, in fact, must have low rates for long-distance movements. The movement into Canada would, however, be an all-rail one in most cases. Scrap is collected from miscellaneous sources and when a carload is gathered is moved direct to point of use. Likewise, exports will seek the ports which have direct sailings and where low rates on this class of traffic are obtainable. Sailings to the Far East from the Great Lakes would be few and far between. For this reason we cannot foresee much scrap using the St. Lawrence route. Taking into account the above factors, the closed season, etc., an allowance of 10,000 short tons per annum seems sufficient.

5. *Imports of pig iron and scrap iron.* During the five years 1910-1914 we imported on the average about 170,000 long tons of pig iron, over three-fourths from England. In the years 1924-1926 our imports were at an average rate of 365,000 tons. In the last two years, however, they have fallen below pre-war levels. Of the 1925 imports, 80 per cent came from Europe and 19 per cent from British India, the remainder coming from Canada. Much use is being made of the secondary Atlantic ports, particularly Philadelphia and in some years New England. Little comes through the Gulf, but fairly large and increasing amounts enter at Pacific ports. Only that pig iron entering at the Atlantic ports is in any way potential traffic for the St. Lawrence Waterway. Much the greater part of this represents simply a surplus production dumped down at our ports. Little or none of it now penetrates to the interior because of the expense of rail transportation on such a low grade product. What chance would there be for such pig iron to find its way into the Lakes?

So far as supplies from India are concerned, it does not seem at all likely that they could reach our interior. Direct sailings between India and the Lakes would be few and far between. But what of bringing in European pig iron? It is certain be-

yond any doubt that no European pig iron, much of which is an inferior product for general purposes, could enter into regular competition with our American manufacture of pig iron, which is carried on under ideal conditions so far as the collection of raw materials and proximity to a huge domestic market are concerned. The same may be said of imports of Newfoundland pig iron, which would be under the same handicap as foreign iron in attempting to compete with our domestic industry. Special grades of pig iron might enter to a small extent and distress shipments of iron might take place, in the case of purchases from Europe. Without attempting further refinement in the analysis, we shall set down the aggregate use of the St. Lawrence for pig iron imports at 20,000 short tons per annum, of which 5,000 tons might represent a movement of special types of pig iron and the remainder, distress movements of an irregular character.

Again turning to scrap, we find average imports of 95,000 long tons in the years 1923-1927. Canada is our major source of supply and Cuba also is important. The two countries accounted for about four-fifths of our imports in this period. The movement from Canada would be mostly all-rail, for reasons previously stated, while our secondary coast ports would have first call on our other imports, particularly the Cuban.[6] It is conceivable that boats coming into the Lakes, particularly from nearby countries, would irregularly bring in odd lots of scrap iron and steel. An allowance of 15,000 tons of this low grade traffic will be included in our final estimates for what it may be worth as a factor in determining the economic feasibility of the St. Lawrence route.

6. "*Intercoastal*" *movements of iron.* The large steel producers, of course, use pig iron of their own manufacture al-

[6] Of our 1926 imports, 87,000 tons, a fourth came in through Buffalo and New York, a fifth through Michigan and other interior gateways, and Maryland accounted for one-fourth and San Francisco for one-seventh. Thus over four-fifths of our imports are accounted for.

most exclusively. The movement of interior pig iron to a plant such as that at Sparrow's Point would therefore be wholly out of the question.[7] Pig iron entering commercial channels is destined principally for the use of iron foundries and fabricators of iron products. Our problem becomes, then, one of determining what pig iron could move, out or in, to such industries. Let us simplify the problem by first eliminating all obviously impossible movements.

Great Lakes pig iron is unlikely to move to the Gulf region, and Southern pig iron is unlikely to move into the Lakes. The two regions are self-sufficient and much of the production is in the hands of subsidiaries of the same companies. Likewise, it seems difficult to expect any Lake pig iron to pass around to the Pacific coast. The Pacific coast demand is limited, cheap foreign supplies are available, and domestic shipments can more advantageously be made from East Coast points and the Gulf. A small amount might conceivably find its way around if accorded low rates. Certainly there would be no movement in the reverse direction.

New England and the general vicinity of New York City are therefore the only regions to which pig iron might move from the Lakes, while the only movement into the Lakes would have to be from Baltimore and eastern Pennsylvania. The New York manufacturing area uses a large volume of pig iron, but, in view of the relatively short haul and long water haul required in reaching it, with a handling or switching charge at destination that is covered in the rail rate, it is unlikely that pig iron would move to that region over the St. Lawrence route. Eastern Pennsylvania and Maryland production is near at hand, while the distance by rail from the Pittsburgh district is only about 440 miles, or about a sixth of the distance by rail

[7] Incidentally, if pig iron were to move to this plant it would merely serve to displace iron ore. Pig iron is in a less favorable position than iron ore for using the St. Lawrence route, since it would require two transportation movements: iron ore into blast furnace and pig iron to market or consumer.

and water through Erie. A little pig iron produced in the lake cities might find its way around irregularly.[8]

To New England the rail distance from important producing areas is greater and the water distance a little less, though this latter is not as significant a consideration as the character of vessel service available, with respect to which New York would be favored.

Since New England produces relatively little pig iron, we can best gauge her consumption of it by noting the amounts brought in by the railroads. In 1927 the New England carriers (except the Boston and Albany, whose statistics are grouped with those of the parent New York Central), transported some 471,-000 tons of pig and bloom iron, compared with 683,000 tons in 1925. The latter figure might be raised to 800,000 to allow for the tonnage carried by the Boston and Albany. There is yet to account for such pig iron as is brought in by water and is not carried by any railroad. Examination of imports by New England customs districts indicates that normally only a very small import tonnage is brought in in this way, and the coastwise movement from furnaces along our Eastern Coast is not large. An estimate of 850,000 tons as the normal consumption of pig iron in New England would be liberal. How much of this could move by the St. Lawrence route?

Pig iron tends to move with considerable regularity throughout the year, its value and market conditions not permitting it to be stored to any such extent as is ore. When deduction is made for movements during the closed season, for movements to points which would require an expensive rail haul back from the ports, for pig iron brought in from other coast points, from Pennsylvania mills, and from foreign countries (the last as distress cargo largely), for such small production as now takes place in New England, and for the fact that many of the New England ports could not be directly served by the packet

[8] The New York Barge Canal also is available and would be a serious competitor in the event a movement via the St. Lawrence were attempted.

service we have assumed to be available, an allowance of even 75,000 tons seems extremely liberal. This amount will, however, be included in our final estimates.

As to the movement of pig iron into the Lakes from the Atlantic coast, there is so little available there for such a movement and cost conditions so clearly run contrary to such an exchange between important production areas, that no traffic of this sort can be anticipated.

In view of the fact that the East Coast has a surplus of scrap iron, no outbound movement to this region can be expected. We shall assume that 25,000 tons might move inbound as ballast traffic.

7. *Exports of other semi-finished and finished iron and steel.* We pass now to a class of exports which far exceed either iron ore or pig iron as articles of international commerce. Our exports of these products averaged some 650,000 long tons in 1901-1905, about 1,175,000 tons in 1906-1910, and 1,945,000 tons in the period 1910-1914. The large exports for the war period and the years immediately following, say 1915-1920, averaged 4,634,000 tons, obviously an abnormally high figure. During three recent years, 1925-1927, exports have averaged 1,859,000 long tons per annum or less than the pre-war average. This tonnage is made up of such semi-finished products as ingots, blooms, billets, and slabs, and of finished products such as structural steel, rails and track material, tubular products, wire and manufactures of wire, nails, screws, bolts, etc.[9] It is impossible, in a traffic survey of this kind, to enter into a detailed consideration of the future markets for each of these classes of product. We must, therefore, deal with aggregates, hoping thereby to gain a picture of the principal considerations which will determine the extent to which iron and steel products could use the St. Lawrence route.

[9] Pig iron is, of course, a semi-finished product, but it and scrap are felt to present a different transportation problem from that presented by the semi-finished products here listed.

Of our exports of iron and steel products in 1925-1927 about 37 per cent went to Canada, 31 per cent to Latin America, 24 per cent to the Far East, and Africa, and only 8 per cent to Europe.[10]

The principal gateways for exports to Canada at the present time are Buffalo, Detroit, and Port Huron. Some cross the border into Canada from upper New York and New England points, and some enter western Canada from Minnesota points. By far the largest part enters Canada all-rail and goes to the two provinces of Quebec and Ontario. Of these the latter is much the more important as an industrial center, but of course use of St. Lawrence would not be involved in bringing traffic from the interior of the country into Ontario. The St. Lawrence would also be a small factor in carrying traffic down to points in the Province of Quebec. In many cases a rail haul would be required at one or both ends; and, at least in the case of shipments from Ohio, Pennsylvania, and New York, the substitution of water for rail transportation would be too slight to be worth seeking. There is also the important consideration that much of this business requires regular and dependable, often fast, service, and that much goes in such small lots as not to warrant the trouble of finding the cheapest routing possible. It looks very much, therefore, as if the principal use would be by the large producers situated in the Chicago district. One such now operates owned or chartered boats on the Great Lakes. Such a concern can adapt its vessel service to its own needs and, with its own plant facilities, can load to advantage. The extent of such use is difficult to determine. Canada's own industrial growth tells against an important expansion of our exports to Quebec. The Ontario and Nova Scotia steel industries, as well as Quebec's own, promise to supply most of her needs. Deducting shipments during the closed season, shipments to points not reached by

[10] The aggregate from which these percentages were computed includes the relatively small tonnage of pig iron and scrap.

water, and miscellaneous shipments requiring rail type of service, an allowance of 75,000 tons per annum would appear liberal.

Finally, would steel products from our Eastern Coast enter Canada via the St. Lawrence? This is to be regarded as unlikely. The movement would continue to be directly north by rail, with the Middle West for the most part supplying western Ontario and the prairie provinces. Some few irregular shipments might be made from plants directly on the coast, but most of these would be unlikely to penetrate beyond Montreal, owing to the competition of our interior mills and to the fact that the Sparrow's Point plant at Baltimore is owned by the same company that has the large plant near Buffalo. Nor can allowance be made for any movement from our more remote Southern and Western coast regions. In neither case do conditions favor use of the waterway.

Let us turn next to Latin America and the Far East, which can conveniently be grouped together. Fifty-five per cent of our exports in 1925-1927, or over 1,000,000 long tons, went to these regions. At the present time the great bulk of our iron and steel exports to these regions leaves by way of New York, with smaller amounts going from Philadelphia and Baltimore, and still smaller amounts from Gulf and Pacific ports. The plant of the Bethlehem Steel Corporation at Baltimore is in a particularly advantageous position for foreign trade and it has been reported that export business in the future will be largely concentrated in the Birmingham[11] and Baltimore plants.[12] It is not likely, however, that all of our export business

[11] The port of Mobile, distant about 180 miles from Birmingham, can be reached by barge after a short rail haul.

[12] Small, independent producers are not likely ever to be a significant factor in exports of iron and steel products. They cannot compete in foreign markets with the quantity production of the larger companies, whose products also are shipped under more favorable transportation conditions, and they are unable to bear the expense of maintaining experts in foreign countries to study

could be handled from these plants. The Birmingham plants have as yet only a narrow line of products, though their output is becoming more diversified. The Canadian business can for the most part be handled best from the Pittsburgh-Great Lakes district, and there is some development, though small, along the Pacific Coast. There also is the important consideration that the large steel companies distribute orders to the plants which at the time most need the business to keep them running on an economical basis. Transportation costs are considered, but only along with all others. So much, then, for the factor of plant location; seemingly a favorable all-water route from the Middle West would be of value to the steel industry. But there are other factors to be taken into account.

Traffic prefers a year-round route to a seasonal one, and it tends to flow to ports which have the greatest volume and variety of traffic, well balanced as to imports and exports. Particularly significant is the fact that the United States Steel Corporation fleet of some 37 vessels, maintained to facilitate its foreign trade, depends in large part for its successful operation on obtaining general cargoes.[13] To divert these vessels from New York to the several lake ports would probably mean a considerable sacrifice of general cargo business and a lower operating efficiency. (See traffic summary in Chapter VI.)

With these factors in mind, let us try to answer the important question as to whether the opening of the St. Lawrence route would effect significant changes in present flow of traffic and present tendencies in the industry.

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and develop the markets. In the Chicago-Gary district, for example, the United States Steel Corporation is the only important exporter, the mills of various independents confining themselves almost wholly to the domestic market.

[13] Aside from the fact that solid shiploads of steel tonnage destined for a certain region are not regularly available, there is the inability of boats to load so heavy a commodity as steel to full capacity and remain afloat. At the present time these vessels ply principally between New York and our own Pacific Coast, the West Coast of South America and the Far East via the Panama Canal.

Let us assume, for the sake of the present discussion, that use of the St. Lawrence route would mean a cheaper rate on exports from the lake ports to seaboard than is obtainable at present. Our first question is whether such a cheaper rate would lead to an important reorganization of the export business of the large potential users of the waterway. Such users, as already indicated, would be very limited in number and would presumably effect a saving in transportation charges by using their own (or chartered) vessels or through being in a position to bid successfully for bottom cargo space in such liners as might enter the Lakes. The margin of advantage over using other routes would, however, be small, since in general it would not be the rail rate from the Gary district, let us say, with which comparison would be made, but the rail rate from the Pittsburgh or Southern plants of the same company. There are also manufacturing advantages in confining the export business, with its special requirements, to as few plants as possible.

For these reasons, and because of the seasonal closing of the route; the difficulty of operating the Steel Company's fleet of ships in world trade and yet embracing sailings to and from the Lakes; the particular handicap as to distance the St. Lawrence would labor under in the case of trade with the West Indies, Mexico, Central and South America, and the Far East; the advantages in using all-rail service in reaching contiguous territories without transshipment; the possibility of using the Mississippi River Barge Line with its differential freight rates, on certain classes of traffic,[14] and the requirement of fast and frequent service in the case of some traffic—we conclude that the St. Lawrence would not work any important changes in the routing of iron and steel products.[15]

[14] The steel industry in the Gary District certainly would use the Mississippi River route in preference to the St. Lawrence route for shipping export products to Latin America and the Far East.

[15] These various considerations have somewhat different setting in the case of shipments from Lake Erie points, but here production is in the hands of smaller concerns, or, in the case of

Some use of the route would of course be made. Part of this, both by the big producers and by the little fellow (so far as he is able to do any exporting at all), would be "occasional" in character and so could not be included in our estimate. But a large order might be taken at a lower price than customary if delivery could be made during the season of navigation and if at the time the lake plants could be used to advantage. Further, there might be some holding back or speeding up of production in order that advantage could be taken of regular liner sailings. Low rates would be expected on such traffic, however, a fact which must be given some weight in determining the significance of the iron and steel trade in our final traffic estimate.

To estimate the amount of such traffic over a period of years is exceedingly difficult. If as a starting point we take the average of the three years, 1925-1927, we have 1,859,000 long tons of total exports, the 55 per cent of which going to Latin America, the Far East, and Africa amounting therefore to 1,023,000 tons. Of this at least three-fourths would, for the various reasons already enumerated (location of plants, advantages in using New York and other North Atlantic ports, etc.), go out by other routes, leaving 256,000 tons as a reasonable estimate of traffic that could originate at lake ports. Deducting no more than two-fifths to represent shipments going out during the closed season leaves 154,000 tons, of which, on a liberal assumption, one-half might use the route [16] on other than an "occasional" basis. The result is 77,000 long tons of traffic. To allow for growth we will increase this figure by 50 per cent, or to 115,000 tons. Converting this to short tons, we have 130,000 tons of traffic.

Lackawanna, is by a company which is certain to use its seaboard plant (at Sparrow's Point) almost exclusively for its export business. It is altogether unlikely that plants in the Pittsburgh district could use the St. Lawrence route for shipments to the south and Far East; the cost of getting to an Erie port would more than offset any assumed saving from there on.

[16] Assuming no other deep waterway outlet is available.

For trade with Europe the conditions are in some respects more favorable (the distance factor and greater frequency of vessel service, for example), but in general the products sent there are of a character requiring a higher type of transportation service than is essential in the case of shipments to the Southern Hemisphere or the Far East. Figured on the same basis we have 149,000 tons, 8 per cent of the total exports, to consider. Assuming that one-half would originate in the Great Lakes territory and that three-fifths would move during the open season, we have 45,000 tons of traffic to consider. Assuming further that one-half of this would use the waterway on other than an " occasional " basis leaves 22,500 long tons, which, increased by 50 per cent as above and converted to short tons represents, let us say, 40,000 tons of traffic.

8. *Imports of other semi-finished and finished iron and steel.* Until a very recent turn of events, our imports of these products have been considerably below the pre-war average. In 1921-1923 the average was only 158,000 tons, as compared with 283,000 tons in 1903-1905. The United States, only a few decades ago dependent to a considerable extent on Europe for iron and steel products, has in the past two decades been able to meet its domestic demand and in fact has become an important exporter of such products. In the last few years, however, our imports have shown a noticeable increase, averaging 482,000 tons in the years 1925-27. This situation, which has caused considerable alarm in the trade, requires explanation.

Practically all our imports of steel products come, of course, from Europe. These have for years entered in large part at our Gulf and Pacific, and to a less extent at our South Atlantic ports—regions at a considerable distance from domestic sources of supply and also regions to which owing to poor load factor low vessel rates have been available. Import rail rates, lower than corresponding domestic rates, have also been available.

In the last few years conditions in the European steel industry and the European financial situation, as well as in ocean shipping itself, have been such that unusually low prices could

be quoted on foreign steel laid down at our ports. This combination of circumstances seems to have been concentrated on the Gulf ports, particularly Galveston, where a great amount of steel has been "dumped" of late.[17] This steel has gone inland as far as St. Louis.

Under more normal conditions in the European steel industry and with ocean freights not only on a permanently higher but on a "regular" basis, it seems clear that little European steel (except special grades) could enter into the very stronghold of American iron and steel production. The fact that we are an exporting nation, and also that relatively little iron and steel can enter at New York (not a producing region) at standard ocean rates,[18] justifies this statement. We therefore can make no allowance under this head other than for movements of special products and for those moving in under distress conditions. An allowance of 10,000 tons per annum would be liberal in the first case. Having regard to the extent of use of Gulf ports at present, with penetration from there into the interior, to the seasonal closing of the St. Lawrence route, to the fact that certain types of product will require the fastest transportation, to the declining importance of tramps, with which distress rates are generally associated, and to the inability of shipments of this class of traffic generally to stand a rail haul back from lake ports,[19] an allowance of 50,000 tons of distress traffic per annum seems all that is called for.

Our small imports from Canada are practically certain to come in their entirety by rail,[20] and such small imports as are

[17] It is said that the competition of German and Italian railways for business has contributed to this situation.

[18] But 29 per cent of our 1927 imports entered via New York, and a portion represented products for which we regularly look to Europe.

[19] As indicated, for example, by the fact that pig iron from India has got as far as Bridgeport recently but has been unable to penetrate to Hartford.

[20] Partly because production is at points requiring but a short, direct haul across the border and because a part represents rails and other materials applied in the tracks, etc., of Canadian railroads having lines in the United States.

received from the Far East are unlikely to enter at other than Pacific and Atlantic ports.

9. *"Intercoastal" movements of iron and steel products.* The final American movement to be considered is that between the Lakes and our various coasts. Let us eliminate at once all the obviously impossible movements. Iron and steel of Pacific or Gulf coast origin certainly could not get into the Lakes. The Pacific Coast industry is too small and too unfavorably circumstanced to tilt with the big lake producers,[21] while the Southern production, with a rail or rail-and-water haul to coast and a long, roundabout movement therefrom, could hardly hope to better its present competitive situation based on the use of rail routes into the North and West. The only Eastern production that might possibly move around in this way would be such as takes place on or in the near vicinity of the coast, and even for such a movement there would be little occasion, since both large companies, that might be in a position to avail themselves of the water service, have plants on the Lakes, against which it ordinarily would not be profitable to move the products of other and more distant mills. The boats of the Bethlehem Steel Company, putting into the Lakes for ore, might bring in part cargoes of semi-finished or finished products from their plant at Sparrow's Point. The extent of such a movement would be extremely difficult to predict. Full cargo movements of ore would likely be on a rather irregular or at least an infrequent basis. Either limitation would bar out much back traffic, particularly that of the higher grades. Under the circumstances, a back loading of 25,000 tons per annum, compared with the 250,000 tons of ore heretofore found to be likely to move in the reverse direction, seems all that could be expected.

The only potential "outbound" movement of iron and steel products that needs to be considered here is that from the

[21] In 1927 and 1928 only 5,500 tons of iron and steel and manufactures left Pacific ports for Gulf or Atlantic ones, as compared with 1,088,000 tons going in the reverse direction.

Chicago-Gary district. There could be no advantage whatever in using the St. Lawrence for intercoastal shipments from the Pittsburgh district, from central and southern Ohio, or West Virginia and Kentucky, while Lake Erie producers either are small ones, usually manufacturing specialities, or have, as in the case at Lackawanna, seaboard plants that can be more advantageously used for the coast business. In fact, as to even the United States Steel Corporation at Gary there is some question whether, operating its own boats, it could effect savings over rail routes from its Eastern and Southern plants.

Semi-finished iron and steel products now take a rate of one dollar a hundred pounds from the steel sections of Illinois, Wisconsin, and Indiana to the Pacific Coast, compared with a water rate of 40 cents from an Atlantic port to the same destinations. Owing to unusual conditions in the inter-coastal trade, this rate is lower than would generally prevail; 60 cents would be a more likely minimum rate under normal conditions. There is seemingly a margin of 40 cents out of which the vessel line could get its pay for coming into the Lakes and the shipper his compensation for using the inferior service. It is difficult to see, however, how normally a rate under, let us say, 80 cents could be made from the Lakes to the Pacific Coast. The margin is therefore cut to 20 cents and this has still to absorb handling and insurance charges of about seven cents a hundred, with perhaps four cents more for handling at the coast terminals, with one trucking or switching charge at point of origin a practical certainty and another at destination a probability. Assuming that five cents would cover the cost of switching and handling at Chicago and three cents the cost at the other end, the margin of 20 cents is practically wiped out, the total cost by water being 99 cents a hundred.

Moreover, there is danger of exaggerating the average size of shipments of even so large an organization as the United States Steel Corporation. Many of its products must move promptly and many would require rail hauls back from the coast that

would be prohibitive of other than a direct rail movement from plant. It is always to be borne in mind also that to collect large shipments at plant for vessel shipment requires extra handling at both ends and warehousing costs. For these various reasons, it is our judgment that relatively little traffic of this character would originate in the Chicago district for shipment to the Pacific coast.

Shipments from the interior of the country to the Gulf coast are almost certain to continue to go down the Mississippi Valley, either all-rail or by rail-and-water routes. From Eastern plants likewise there obviously could be no use made of the St. Lawrence waterway.

Our last question relates to shipments from the interior to Atlantic coast points. Here the answer depends largely on service considerations. There could, of course, be no comparison in the service; in frequency, convenience, and time in transit rail service would be immensely superior in this case.

The large steel plants, with boats occasionally plying between the Lakes and the coasts, doubtless would carry some steel to the Atlantic ports and a little might move by packet service. The allowance to be made involves a highly speculative judgment. An aggregate of 100,000 tons appears to be about all that could be expected to move in this fashion.

10. *Canada's use of the St. Lawrence waterway for the movement of iron ore, iron and steel.* We find that exports of ore are negligible and move wholly to the United States. Canada is in no position to enter into the exportation of iron ore. She is now and probably will long continue to be on an import basis.[22] Again, her imports of ore are wholly from the United States and Newfoundland. The former movement has already been considered. Obviously, the Newfoundland ore, which moves a short distance across to Nova Scotia, where there is coal, could make no use of the St. Lawrence unless perhaps

[22] Ontario has extensive deposits of low grade iron ore, but there is no prospect of its paying to work them under present conditions.

small quantities of it were to move up the river to Ontario blast furnaces. The movement into Ontario is likely to continue for many years to be preponderantly from the Lake Superior mines, which are nearer and more easily reached. The St. Lawrence could not serve this traffic.

It is likely, however, that the improvement of the St. Lawrence would more nearly equalize transportation costs as between the Superior and the Newfoundland regions. While there is reason for serious doubts as to whether anything approaching the efficient bulk cargo carrier now used in the ore trade on the Great Lakes would be called into use in bringing ore from Newfoundland, there is a possibility that tramps and others bound for lake ports would occasionally pick up small lots of Newfoundland ore to help fill up cargo space. The distance the ore would move would be relatively short, of course, and so long as Lake Superior ore is available it is fairly certain to dominate the situation in the interior of Canada. For these reasons an allowance of only a small amount of ore tonnage can be made. We will set this at 75,000 tons per annum, which represents about one-tenth of the Canadian imports from the Lake Superior region in recent years.

No Canadian " intercoastal " movement of iron ore over the St. Lawrence route would be possible, in view of the foregoing statement of the factors in the Canadian iron ore situation.

Canada's exports of pig iron go practically in their entirety to the United States and so have already been considered. Her imports of pig iron, ingots, blooms, and billets also come in large part from the United States and have also been considered heretofore. The remainder comes almost wholly from the United Kingdom. No satisfactory statistics are available showing where the pig iron imported from abroad is used in Canada or how it reaches such points. Bearing in mind the facts that Canada's steel production has rarely exceeded 1,000,000 tons a year, the large proportion of her pig iron that is produced in her own blast furnaces (for technological and other reasons heretofore explained), and the usual seasonal and other limi-

tations on the use of the St. Lawrence, an allowance of 50,000 tons of imported pig iron and related products would be liberal. Possibly allowance should also be made for movements into the Canadian interior of Nova Scotia pig iron. We will set down, as a liberal estimate, an additional 50,000 tons under this head.

Canada's international trade in scrap iron and steel is almost wholly with the United States and so has already been considered. The figure last given above is liberal enough to include any domestic movements via the waterway.

There is finally the question of Canada's use of the waterway for the movements of finished iron and steel products. Canada is not a large exporter of such products. In the last four years her total exports probably did not average over 50,000 tons per annum and of these about a third passed into the United States, and doubtless a good part of the remainder went to Newfoundland. Furthermore, Canada may logically be expected to do a large part of her exporting from her Nova Scotia mills, which of course lie without the range of the St. Lawrence. The presence of mills at Toronto, Hamilton, Sault Ste. Marie, and other points reached by water suggests that some effort would be made to use the St. Lawrence waterway service. But much of Ontario's production is of the more highly fabricated types of iron and steel products, which would tend to seek the superior service available from Montreal; and much of the production takes place at inland points which, requiring a rail haul in reaching a port, would be likely to look to Montreal as the favored shipping point. Having regard also to the various other limiting factors named above, an allowance of 25,000 tons per annum would be liberal in predicting traffic as of about the year 1940.

Though Canada imports a considerable volume of iron and steel products, about 85 per cent comes from the United States and so has already been considered. The remaining imports probably would not average over 135,000 tons per annum in

recent years.[23] About 60,000 tons of iron and steel imports are reported to have come in at Montreal in 1925. Montreal is, of course, a large distributing center. This fact and the better overseas transportation service available there promise to continue to bring a large part of Canada's imports in at that point for rail distribution from there. Some might, however, pass directly into the lake cities, particularly Toronto, for use there and in adjacent territory. Taking into account this rivalry of distributing centers, as well as the effects of the closed season, it would appear liberal to suppose that 50,000 tons would pass over the St. Lawrence route.[24]

Finally, there are Canada's internal movements to consider. The lack of statistics makes study of this phase of the subject extremely difficult. Having regard to the fact that the fabrication of iron and steel products takes place largely in Ontario, Canada's important industrial center, and the distribution of Canada's population,[25] which shows how largely the points of use of iron and steel products in the stages we have been considering are close to points of production, no extensive interprovincial movement via the waterway can be foreseen. Some Nova Scotia products might move west and perhaps some Ontario products east to Montreal and other river or gulf points. But for the most part this would be short-haul traffic that is likely to go by rail in very large part. Transfer charges and other incidentals would quickly eat up any savings from

[23] Taking all products for which tonnage statistics are obtainable, we find that of an average of 698,000 tons in 1924-1927, 561,000 tons originated in the United States, 98,000 tons in the United Kingdom, and 39,000 tons elsewhere. The most important omission is castings and forgings, which, however, come largely from the United States.

[24] Estimated by increasing the above 125,000 tons to 200,000 tons to allow for growth, and by assuming that three-fifths of this would pass through Montreal or come in at Canada's Pacific ports, and that about two-fifths of the remaining 80,000 tons would move in the closed season and therefore have to be routed in other ways.

[25] In 1921 Ontario and Quebec had 60 per cent of the population, the eastern provinces about 11 per cent, the prairie provinces 22, and British Columbia about 6.

the substitution of water for rail transportation. A part of such movements as might take place by the waterway would also be "occasional" in character, particularly in the case of the highest class articles. Though without substantial basis for making an allowance for these internal movements, 50,000 tons will be set down as giving some idea of the order of magnitude.

Our estimates of traffic in short tons, may be summarized as follows:

Trade	United States	Canada	Total Traffic
Iron ore:			
Exports	...	...	...
Imports	...	75,000	75,000
Domestic	50,000	...	50,000
Pig iron and scrap:			
Exports	18,000	...	18,000
Imports	35,000	50,000	85,000
Domestic	104,000	50,000	154,000
Other semi-finished and finished iron and steel:			
Exports	170,000	25,000	195,000
Imports	60,000	50,000	110,000
Domestic	200,000	50,000	250,000
Total	637,000	300,000	937,000

II. Manufactures of Iron and Steel

1. *Heating and cooking apparatus and appliances.* Two general classes of products will be observed here.

a. *Boilers and radiators.* Our exports of these products have not been large, averaging less than 4,000 tons in 1925-1927. A large part—56 per cent in 1926—goes to Canada. The American industry is largely in the hands of a few companies. New York and Pennsylvania have the largest number of important plants, with Michigan, Ohio, Indiana, Illinois, Missouri, Kansas, and Alabama also represented.

The European demand is amply taken care of by the plants of one of the large American companies, of which there are

twelve in six different countries. The countries to the south of us do not afford an important market.

We export a few thousand tons of these products to the Far East; but for reasons discussed in Appendix G such traffic would not move from the Middle West to the Orient via the St. Lawrence.

What, next, is the possibility of making shipments to the coasts from interior points? We can at once eliminate consideration of shipments to our Eastern and Southern Coasts, whose needs would be supplied from local plants. Could a rate be made low enough to offer inducement to ship from Detroit and Buffalo (the two important production points on the Lakes) to the Pacific Coast in competition with plants (of the same companies) on, or nearer to, the Eastern Coast? Shipments of boilers and radiators are of two general classes: direct movements from factory or warehouse to the job, a movement usually of no great length that requires individual handling and often direct and quick delivery; and, second, movements from factory to warehouse. The latter might, it would seem, make use of a slower and irregular water transportation service, but here again we are confronted with questions of relative production costs at the different plants of the same company and with the frequency of service and the rates likely to be available out of the Lakes. A small amount of this traffic might go around to Pacific Coast warehouses if it were accorded low rates. An estimate of 2,500 tons per annum is made.

Movements in the reverse direction—from coast regions into the Middle West—seem quite unlikely. The lake region is able to meet its own requirements, together with some shipments in from interior New York, Pennsylvania, and other plants.

Canada's imports under this head are very largely from the United States. Her exports are of minor extent. To make some allowance for production at such places as Toronto and Hamilton, Ontario, 1,000 tons of exports will be included in our estimates. Domestic movements would be unlikely to involve use of packet service on the St. Lawrence.

b. *Stoves and ranges, warm-air furnaces, and water heaters.* Our exports of these products have averaged a little less than 20,000 tons per annum in recent years. The industry is, in fact, so organized that the great bulk of the manufacturers, mostly of small size, do not look beyond the domestic market at all.[26] Our most important markets for cooking stoves, ranges, heating stoves and warm-air furnaces are Canada, Latin America and the Orient. Europe, especially England, is an important market for oil and gasoline stoves. Business is on a year-round basis, but with a dull season from the middle of June to the middle of August. A rather high grade of transportation service is required.

Deducting exports to Canada, which would move all-rail, our exports in recent years have run about 13,500 tons. To allow for considerable growth, we will raise this figure 50 per cent, or to 20,000 tons. Of this a relatively small part, consisting mostly of oil and gasoline stoves, would represent shipments to Europe. In view of the location of points of production (Massachusetts, Ohio, etc.), and the high type of service required, it is our conclusion that any use that might be made of the St. Lawrence for moving this traffic to Europe would be " occasional " in character.

A very considerable part of the exports to non-European countries passes out through Southern and Pacific gateways, as would be expected in view of the large inland production and the location of our principal markets. Of the total of about 10,000 tons of exports remaining (allowance being made for

[26] In 1926 there were 432 different plants engaged in the manufacture of all kinds of cooking and heating apparatus (except boilers and radiators). Of these, Ohio had 78, Pennsylvania 53, Illinois 52, New York 40, Michigan 27, Indiana 26, Missouri 23, etc. Somewhat more than half the 1921 production was credited to the states bordering the Lakes, but of 52 Illinois plants only 16 are on the Lakes, 8 of 27 Michigan plants, 20 of 78 Ohio plants, 2 of 7 Minnesota plants, 6 of 10 Wisconsin, and none of the 26 Indiana plants. In all these states much of the production is at points remotely distant from the Lakes.

expansion) a very considerable part would move from Eastern points; a part would move through non-Atlantic gateways; a part would move during the season when navigation on the Lakes is closed; a very considerable part would be routed for the quickest possible delivery, which means rail to New York or other ocean ports and fast boats therefrom; savings that may be apparent from using the St. Lawrence in the remaining cases would be offset in part by trucking costs, the necessity of adjusting to the occasional vessel that would be available, etc. It is our belief that exceedingly little tonnage of this sort would use the St. Lawrence route. To make some allowance, however, we will set down as a total exports figure, 500 tons per annum.

As for trade with the coasts, obviously only that with the Pacific coast requires analysis. The only stove manufacturers who could use such a route would be those in the immediate vicinity of the Lakes, as at Detroit. So roundabout would the route be that the slower delivery time, taken with the only minor savings that might accrue, leads to the conclusion that no significant amount of this traffic would develop. As it is now, loading can be at factory door and unloading at jobber's warehouse, a simple, regular, and expeditious way of handling the business. Damage would also be less with the fewer handlings. Movements to the coast now appear to go mostly all-rail, despite the very low intercoastal rates.

The situation is different in the case of furnace manufacturers, who send castings and other parts to the coast for assembling there. This is typical low-class freight which could use water transportation. It is impossible to obtain statistics of the amount and manner of present movements to the Pacific Coast. Comparing the importance of these products with that of boilers and radiators, we should not anticipate that more than 1,000 tons of this traffic, at the most, could advantageously use the route.

Canada's exports of stoves are of negligible amount and her imports are almost wholly from the United States.

2. *Enameled ware of iron and steel.* The most important items here are sanitary goods—bathtubs, lavatories, bowls, sinks, etc. We exported in 1925-1927 an average of 18,600 bathtubs, practically all of which went to Latin America and the Far East. Canada and Europe took few. Of the other class of products we exported an average of 54,000 pieces in 1925-1927, with Canada slightly more important in this case. In all, our exports at the present time can be estimated at 23,000 tons annually.

Though a considerable part—perhaps a third or more—of the production takes place in the Middle Western states adjoining the Great Lakes, production, in many instances, is not at points where direct loading could be made on ocean-going vessels. A rail or other haul to a port having liner service would be necessary. There is some production at points in the vicinity of some of the minor ports, but this is not a class of traffic which could go in large enough lots to attract boats to such ports. It is rather a type of traffic which generally requires frequent and dependable service and which moves the year round. Furthermore, some of the large producers have Eastern and Southern plants which would almost certainly be used for the export trade, particularly in the case of shipments to the Orient and to the countries on the south of us.[27]

The only possibility of use of the St Lawrence seems to be, then, that such of the manufacturers as have plants only in the Middle West and either at the principal lake ports or at other points from which a short rail or other haul would put their production into such ports, would find it possible to make some of their larger, irregular shipments by the waterway service. Thus certain shipments on large contracts or stock shipments to an agency abroad might be made, with the general

[27] Shipments destined to Cuba now move all rail to a Florida port, thence by car ferry to the island.

run of the business going in part by rail to coast ports having frequent service and in part on an "occasional" basis from the lake ports. Allowing liberally for growth of total exports, it does not seem possible that more than 1,500 tons of traffic could be assigned to this group of products.[28]

Taking into account the location of plants, it appears unlikely that there would be any large interchange of enameled ware between the Great Lakes and the Atlantic and the Gulf coasts. Each region is more or less self-sufficient. Companies having only interior locations would be interested, of course, in reaching the coast under more favorable transportation rates, but the location of these companies is such that in practically every case a local movement to points of call of the packet service would be necessary. Service almost as good as that available by the rail lines is expected, but of course nothing remotely approaching this could be available. For these reasons it seems best to classify any use that might be made of the available packet service as generally "occasional" in character. As a matter of fact, little traffic would move even on this basis, for the saving, after payment of rail haul, transfer charges, and extra handling at other end, could be only slight. To our Pacific Coast the advantage could be only less, for the water rate would be higher than to our other coasts and the service probably less frequent. All things considered, it is likely that shipments to the West Coast would continue to be made from Eastern or Southern plants or from the interior directly west by rail.

[28] Estimated as follows: 1925-27 exports, 23,000 tons, increased to 40,000 tons to allow for growth; three-fourths of exports assigned to Eastern and Southern plants, leaving 10,000 tons; two-fifths of this assumed to move during closed season, leaving 6,000 tons; one-half of remainder assumed to originate at lake ports or able to reach such ports for vessel shipments; and, finally, one-half of the remainder, or 1,500 tons, assumed to be large, irregular shipments of the kinds indicated above. The assumptions have, if anything, been unduly liberal throughout.

Canada's imports under this head are largely from the United States and so have already been considered. Her exports are not extensive and production is to some extent at Eastern points beyond the reach of the St. Lawrence and in some cases is in the hands of subsidiaries of American concerns who would use plants in the United States except where tariff considerations dictated another course. Without attempting a detailed analysis, an estimate of 500 tons of traffic to move under the conditions set forth in connection with shipments from the United States would appear to be liberal.

In view of the character of service required and the location of the principal Canadian manufacturers of these products, it seems reasonable to expect the great bulk of the shipments between interior Canadian points within the reach of the St. Lawrence waterway to be rail shipments, with perhaps " occasional " shipments via the infrequent packet service assumed to be available.

In addition to the heavy enameled goods considered above, there is enameled household ware to consider. Our exports of this class of goods are, from a tonnage standpoint, small, being under one thousand tons in 1927. This again is a type of traffic that requires a fair degree of frequency of transportation service. Our markets are largely in Latin America and the Far East. Shipments are made in relatively small lots and manufacturers do not carry stocks abroad. For these reasons, any use that might be made of the route would be indubitably stamped as " occasional " in character and would be extremely limited at that. Imports also are very small, and, while a little of this ware might be brought directly into the Lakes by the large mail order houses and department stores there, such traffic would be negligible from a tonnage standpoint.

The same considerations govern Canada's use of the waterway for this class of traffic.

3. *Metal furniture.* Here are included filing cases, safety deposit boxes, vaults and locks, office furniture and fixtures, etc. Safes are considered separately. We do not import any of these items. Our exports in 1924 and 1925 averaged about

14,000 tons and have increased since. Europe took about a seventh, Latin America, the Far East, and Africa, five-sevenths, and Canada close to a seventh. Clearly, the movement into Canada would be an all-rail one. This is a high class of traffic and production is largely in the states that border Canada—New York, Ohio, and Michigan. Likewise with shipments overseas, a faster and more frequent vessel service is required than is likely to be available out of the Lakes. Rail hauls to lake ports also would tend to detract from the use of such service as might be available, through materially cutting into any possible savings. It is possible, however, that a little tonnage, other than "occasional," would be available out of the Lakes. This might represent shipments to warehouses abroad or merely large, irregular orders available for movement when vessel service was available. Also, our exports of this class of goods are likely to show a considerable expansion in years to come. Unfortunately, our best markets are in regions least accessible to the St. Lawrence route. Allowing for all these factors, including the effect of the closed season and the continued drawing power of New York with its frequent and varied sailings, not more than 1,500 tons of this traffic can be foreseen.[29]

4. *Safes.* We import no safes. Our exports averaged 10,000 in 1925-1927, or, at one-half ton to the safe, 5,000 tons. Canada takes a fair portion, but Europe very few; our best markets are in Latin America and the Far East. About 75 per cent of our exports pass through New York, with a considerable part using other Atlantic and Gulf and Pacific ports. In transportation requirements this traffic is very similar to that last discussed above. Production is pre-eminently in Ohio, but in most cases at points which would require a rail haul to get shipments to shipside. New York and other states are of some importance also. Possibly 500 tons of this traffic would find its way out

[29] Computed on the basis of double our recent exports.

over the waterway on the liberal basis indicated in connection with metal furniture.

Canada's imports of metal furniture and safes are almost wholly from the United States and so have already been considered. Her exports are not extensive and by the time deduction is made for shipments that would be made via Montreal (owing to its nearness to some of the points of production and to the better transportation service available from there) and for shipments during the closed season, there is only an insignificant volume of traffic left.

5. *Firearms.* No use of the St. Lawrence would be possible in this instance, owing to the fact that production is almost wholly in Connecticut, New York, and Massachusetts, and to the high type of transportation service required. A very small amount of imports might be brought directly into the Lakes from Europe by a few large merchandising establishments, but such traffic would be trifling in extent.

6. *Cutlery.* Here again the predominance of the East Coast states in production and the character of service required make use of the St. Lawrence out of the question. A small amount of imports might find their way directly into the Lakes, but in volume such imports would be very slight.

7. *Hardware and tools.* Though in the aggregate our exports of hardware and tools are quite extensive (possibly about 50,000 tons in recent years), they are made up of a great variety of items and go to a very wide scatter of countries. Our most extensive markets are in Latin America and the Far East. This also is a high class of traffic which moves freely in commerce. Production is large in the New England states, in New York and Pennsylvania, and in Illinois, Ohio, and Michigan. Much of the production in the last group of states is, however, at points back from the Lakes. Shipments are characteristically of small volume. Exports move very largely through the port of New York, where both shipping and administrative facilities for handling them effectively are available.

On the basis of these data it must be concluded that the infrequent sailings likely to be available out of the Great Lakes to the destinations named would not be attractive enough to lead the industry to adapt its export practices to it. Some use of the route might be made but only on an "occasional" basis.

Imports are of small extent. A small amount might be brought directly into the Lakes, though such use would be so small as not to warrant a separate estimate.

Shipments between the Great Lakes and the coast are almost certain to continue to be by rail, except possibly "occasional" shipments by packet service. In a word, this class of traffic is not adapted to infrequent and slow boat service, and small savings in transportation charges (possible in some instances) would not compensate for inferior service.

What has been said applies equally to Canada. Her exports are not large and go largely to the United States. Her imports are mainly from the United States.

8. *Scales and balances.* Included under this head are both heavy scales and the light scales used in retail establishments. The latter probably make up the bulk of our exports, averaging 122,000 in number in 1925-1927. Our best markets in these years were Latin America, with Canada second, and the Far East and Africa third. Europe takes few. This is distinctly a type of traffic that requires frequent, reliable, and expeditious service. Large stocks are not carried abroad and many of the shipments take place during the season when navigation is closed on the Lakes. These products, at best, could be expected to furnish only "occasional" traffic for the St. Lawrence.

We have no imports, and movements between the Great Lakes and our coasts are definitely stamped as rail movements.

Canada's use of the waterway for her small foreign trade in scales and balances would be subject to the same limitations as our own.

9. *Other manufactures of steel.* This last group consists of power transmission apparatus, ball and roller bearings, and a

large miscellaneous class. The total of exports was 100,000 tons for 1925. Close to a fourth goes to Canada; our largest markets, however, are in Latin America and the Far East. For the most part this is traffic that moves in small lots, generally on special order, and that requires a high grade of transportation service. Though New York is distinctly the one important point of export, extensive use is also made of other Atlantic, Gulf, and Pacific Coast ports.

It is manifestly impossible to analyze this broad group of products in detail. For the most part essential information, such as points of origin, is lacking. Comparing this traffic with other traffic we have analyzed and making the necessary deductions for production at points not accessible to the St. Lawrence waterway, for movements requiring frequent and expeditious transportation service, for movements to contiguous countries and during the closed season, and for the likely paucity of vessel service to the major destinations, an allowance of 5,000 tons of traffic under this head would be distinctly liberal.

Our imports of this same general class of products were valued at $2,223,000 in 1925. There is no basis on which to convert to actual tonnage; our estimate is, however, that there are about ten or twelve thousand tons of traffic here. Europe is the chief point of origin and a wide scatter of points of importation is to be observed. A considerable part is credited to the interior customs districts. Being a miscellaneous group, individual shipments would not be large and probably for the most part a good type of transportation service would be required. Without carrying the analysis further, we will set down, more or less arbitrarily, 5,000 tons of traffic for the St. Lawrence route.

Movements of such traffic between the Lakes and our coast cannot be traced, owing to lack of statistics. Doubtless some of the items have been included in our previous analyses and much of the traffic that might use the route would be only of

an " occasional " character. The omission of an estimate under this head is, therefore, not serious.

Canadian exports and imports of iron and steel and manufactures thereof have been accounted for in previous analyses. Any movements between provinces via the St. Lawrence would be wholly unpredictable in the absence of statistics. Our best judgment is, however, that such short movements of a high grade of traffic would use rail service for the most part and packet service only " occasionally."

APPENDIX F

MACHINERY AND VEHICLES

I. Manufacturing Equipment

The group of products dealt with under this heading is a diversified one including metal working machine tools of various kinds, the machinery required in various kinds of manufacturing establishments, and also machinery products. With few exceptions, all of these products represent a special order business, direct from manufacturer to user, requiring in most cases rapid movement to effect promised deliveries. Not infrequently the foreign buyer is represented by a broker or forwarding agent who attends to the routing and dispatching of the shipments. Such agents are found mostly in New York where the necessary variety and frequency of shipping services are found. Accordingly, it is necessary to consider whether such facilities would be duplicated at the lake ports, or be dispensed with. The "pool car," consisting of a number of exports shipments moving in one lot to ocean shipping points, plays an important part in the transportation of many of these products.

In the case of this whole group of products, unless otherwise stated, a growth of exports amounting to 50 per cent by the year 1940 is assumed.

1. *Metal working machine tools.* Included in this group of products are lathes, milling machines, planers, grinding machines, etc. The industry is not especially concentrated, the leading single state in point of output being Ohio, with Connecticut, Rhode Island, Massachusetts, Pennsylvania, New York, and Illinois being important. A little less than one-half of the total output is from the group of Middle Western states adjacent to the Great Lakes—Ohio, Indiana, Michigan, Wisconsin, and Illinois. A considerable part of the production in

these states, however, takes place in cities back from the Lakes, the leading city in point of production in Ohio, for example, being Cincinnati.

Complete export tonnage figures are not available, but calculations we have made indicate that they have been running around 30,000 tons a year. They have gone chiefly to a few European countries, especially England and France, to Canada, Cuba, and Mexico, to Argentina, to Japan, and to a less extent, to British India and Australia.

For reasons discussed elsewhere, it is only in connection with exports to North Europe that shipping services would be available for this type of product. Assuming an export of 45,000 tons by 1940, only a fraction of which would go to North Europe and much of which originates at interior points, 3,000 tons may be taken as the amount that might find it advantageous to use the St. Lawrence waterway.

In view of the fact that the Middle West is itself a great manufacturing center for metal working tools, we do not import such products to any appreciable extent.

Canadian exports are of negligible extent. Her imports come in considerable part from the United States. One thousand tons is an ample allowance for imports from other countries than the United States.

2. *Paper and pulp mill machinery.* Exports under this head averaged about 7,700 tons in 1925-1927. Canada took over three-fourths of these, and Cuba, England, and Japan a large part of the rest. If we increase the 7,700 tons by about 50 per cent to allow for growth, getting 11,500 tons, and then deduct therefrom the portion going to Canada, we have some 3,000 tons for further consideration. If this in turn be reduced for the production which takes place in the Eastern states, or by three-fourths, we obtain 750 tons of exports as possibly originating in the states adjacent to the Great Lakes. Considering the closed season and the other handicaps of the St. Lawrence route, particularly in reaching the Orient, 200 tons might, on a liberal estimate, use the waterway.

Canada appears to export none of these products. Her imports, other than from the United States, are of fair amount and come almost entirely from England. With the growth of the pulp and paper industry in Western Ontario, it is not unlikely that some use would be made of the waterway. Such use might be estimated at 300 tons per annum.

3. *Wood-working machinery.* Our exports of sawmill and other wood-working machinery averaged something over 4,000 tons in 1925-1927. Shipments go to all parts of the world, but particularly to non-European countries. Production is perhaps two-thirds in the Middle West, but mainly at points back from the Lakes, as at Rockford, Illinois, Grand Rapids, Michigan, Cincinnati and Defiance, Ohio, etc. New York is of course the principal point of export, with the Gulf and Pacific coast gateways also of importance.

Raising the aforesaid 4,000 tons by 50 per cent to allow for growth and reducing the resultant 6,000 tons by one-third for production in the East leaves 4,000 tons. Deducting one-half for movements during the closed season leaves in turn 2,000 tons. Movements into Canada would be mostly all-rail. We shall be liberal if we conclude that one-seventh of the foregoing amount, or, let us say, 300 tons per annum, would find it profitable to use the St. Lawrence route. The reasoning is that used in connection with other like commodities.

Canada's imports are almost wholly from the United States and her exports are small.

4. *Flour-mill and grist-mill machinery.* Our exports of this class of products averaged about 2,000 tons in 1925-1927. Most of these went to the countries to the south of us and to the Far East. Pennsylvania has been the largest region of production, with New York, Indiana, Wisconsin, Minnesota, etc., also important. Important producers are found at Indianapolis, Kansas City, Milwaukee, Minneapolis, St. Louis, Chicago, and other Midwestern cities. Extensive use is made of our Southern and Pacific gateways for exports. In view of the small aggre-

gate size of our exports, the location of our best markets in relation to the points of manufacture, in addition to the usual considerations applying to the routing of special machinery, it appears that no significant use would be made of the St. Lawrence waterway. The same may be said of any Canadian exports.

5. *Sugar-mill machinery.* As nearly as can be determined from the available statistics, exports of these products range from 25,000 to 40,000 tons. The market is, of course, almost solely in the countries to the south of us and in the Far East. Production takes place largely in the East, both at seaboard points and inland. There is some production in two or three important Lake cities and at other Midwestern points. New York is the large port of export, with the Gulf ports also important and to some extent the Pacific ports.

If we assume 60,000 tons of exports by 1940, a 50 per cent increase over present exports, and deduct two-thirds for exports originating at Eastern points, we have 20,000 tons for further analysis. Assuming that one-half would pass out during the closed season leaves 10,000 tons to move from the states adjacent to the Great Lakes during the season of navigation. If we assume that a fifth of this remainder, or about 2,000 tons, would use the route, our estimate will be distinctly liberal. No movement to our coasts by water is foreseen in the case of traffic of this character. Canada's exports, if any, are small.

6. *Rice-mill machinery.* Our exports of this product are small, being about 450 tons in 1925-1927. These go mainly to the Far East, to Mexico, Cuba, Central and South America, and to Canada. Canadian exports, if any, are extremely small. Production is almost wholly at points from which the St. Lawrence could not be of service. No use of the waterway is indicated.

7. *Oil-mill machinery.* Exports under this head averaged some 2,400 tons in 1925-1927. They went mainly to the coun-

tries to the south of us and to the Far East. This fact, taken in connection with the location of the manufacture of these products, which is mainly central and southern Ohio, and the need for expeditious delivery, makes it wholly unlikely that any use could be made of the St. Lawrence route.

8. *Textile machinery*. Production of textile machinery is almost exclusively in the Eastern states. There is, therefore, no likelihood that any exports would find their way out over the St. Lawrence waterway.

In 1925-1927 we imported some 11,000 tons of textile machinery. Only a very small fraction of this found its way into the Middle West. Canada imported on the average during 1921-1925 some 1,200 tons of textile machinery from countries other than the United States. Many of her textile mills are in Ontario, and so the St. Lawrence might here be of service. We may liberally estimate use of the waterway to the extent of about 400 tons per annum, of which 100 tons would represent American and 300 tons Canadian imports.

9. *Shoe machinery, except sewing*. Our exports of these products in 1926 and 1927 amounted to about 1,000 tons. Production is in the Eastern states. No use of the St. Lawrence route is indicated. Canada's shoe machine industry is largely at Montreal; here also the St. Lawrence could be of no service.

10. *Sewing machines*. There are two types of sewing machine, the domestic and the industrial. Of the former we exported an average of 200,000 in 1925-1927, with Latin America our best market, and of the latter an average of 55,000 in 1925-1927, Europe being our best market. An average of 725 tons of parts were also exported in these years. In 1925 there were, we estimate, approximately 30,000 tons of such traffic. New York is the one important point of exportation, accounting for 90 per cent of the total. Production is large in such states as Indiana, Illinois, New Jersey, and Massachusetts. In Canada it takes place at St. Johns, Quebec, near Montreal, and at Guelph, Ontario, not far distant from Toronto. Both Canadian companies are subsidiaries of American or British ones. Canada,

in fact, does quite a large export business in sewing machines. Her imports come very largely from the United States.

After careful weighing of all the controlling factors, the conclusion is reached that no significant volume of this traffic would use the St. Lawrence waterway. (a) Points of production do not favor such use. Most of the interior plants would require a rail haul or a long trucking haul to reach a lake port. (b) Some of the interior plants are used for domestic business only, exports being handled from Eastern plants, and many do not attempt to enter the foreign market in any important way. (c) The largest market for domestic sewing machines, Latin America, is with the greatest difficulty and least advantage reached via the St. Lawrence, while in the case of the industrial machine, our largest market for which is in Europe, production is principally in the East. (d) This is a type of traffic which requires reasonably good transportation service; long delays in getting shipments under way could not be tolerated. This fact is attested to in part by the great use made of New York, which serves also as a convenient point to break up large lot shipments into individual consignments for dispatch by the frequent vessel service available there. As a rule, the individual consignment is not large and the daily variation in the make-up of shipments would tell against such control of deliveries as would be necessary if effective use were to be made of the waterway.

If, then, we eliminate from our total of exports the large portion that would move from Eastern plants, the portion of our total exports moving into Canada and during the closed season, the portion of exports from the Middle West that could not find a saving in the use of the waterway in view of the cost of getting to lake port; and the portion of the production at lake ports (Chicago, Cleveland, and Toledo) that could not await the infrequent, irregular, and slow service likely to be available between that region and Latin America and the Far East, there are left perhaps 1,000 tons of traffic that might use the waterway.

While Canadian shipments would be almost wholly from Montreal, we may set down 500 tons to represent shipments that might be made through Toronto.

Our imports of sewing machines and parts are not extensive and are likely to continue to come in through New York. We will set down, however, 300 tons of such traffic to allow principally for possible importations of parts by Midwestern factories. Canada's imports from the United Kingdom, the only country other than the United States from which they are obtained, have steadily declined in recent years. If we set down another 200 tons here we shall be more than liberal.

It is difficult to see how there could be any "intercoastal" business in sewing machines. A limited number of Midwestern plants might have an infrequent packet service available, but shipments must move promptly and the net saving, if any, in transportation charges, after paying for extra handling at both ends, would not be sufficient to compensate for the inferior service. The same must be said of shipments into the interior from Eastern plants.

11. *Printing machinery.* Included under this head are typesetting machines, printing presses, and other printing machinery. Our exports of these products probably have not reached 10,000 tons in recent years. Our biggest market is found in Europe, with the Far East, Canada, and Latin America following. The production of this general class of machinery is fairly scattered, but with the East generally more important than the Lake states. In the Middle West, Chicago, Cleveland, Battle Creek, Cincinnati, Kalamazoo, and Milwaukee appear to be of most importance.

Printing machinery is akin in its transportation characteristics to many of the other types of machinery previously considered. That is, it moves as a rule on special order, requires predetermined delivery, and, in general, is a type of traffic which puts service above minor savings in transportation charges. In other words, it is not traffic which would be held back or pushed forward in production merely to take advan-

tage of a possible saving in freight costs. Furthermore, from inland points like Cincinnati and Battle Creek there could be little, probably no, net saving from the use of the route.[1] In view of the character of the traffic, then, and of the many other considerations which dictate the use of the ports giving the most frequent and dependable service, it appears likely that New York would continue to be the one important port of export.[2]

Everything points, then, to the lake cities themselves as the only possible points of origin of traffic that might use the St. Lawrence route. These prove to be Chicago, Cleveland, and perhaps Milwaukee. But there would be little adaptation of shipments to vessel service available; if an order was ready for movement when a boat happened to be sailing for the right destination, it might be moved via water. But so infrequent would the liner service be and so compelling such considerations as expeditious delivery, that it appears reasonable to state that any traffic in printing machinery which might find its way out over the St. Lawrence would be "occasional" in character and negligible in extent.

"Coastwise" shipments of this type of traffic could hardly be diverted to the limited packet service that might become available.

We have no imports of this class of product.

Canada exports relatively little under this head and most of this to the United States. No use of the St. Lawrence is indicated. Her imports are almost wholly from the United States, only small amounts coming from the United Kingdom. Receipts via the St. Lawrence, if any, would be of exceedingly small extent.

[1] See discussion of automobile traffic for certain computations of rates.

[2] For these other considerations see, for example, the analysis of automobile traffic, pp. 422-47. New York accounted for 84 per cent of our 1924 exports of printing machinery (omitting exports to Canada), Philadelphia, Gulf, and Pacific ports accounting for most of the rest.

12. *Brewers' machinery.* Exports of brewers' machinery were at an average rate of 2,250 tons in 1925-1927. The countries to the south of us and Canada provide our best markets. Production statistics are not obtainable. When deduction is made of exports to Canada, nearly half of the total, and allowance is made for such other factors as production at points not within the reach of the St. Lawrence, effect of closed season, and shipments that must move promptly, no significant amount of traffic remains that might go over the St. Lawrence.

13. *Refrigerating and ice-making machinery.* Exports of these products averaged less than 10,000 tons in 1925-1927, and, with the exception of some sent to Canada, practically all went to the countries to the south of us and to the Far East. The market for certain types of these products appears to promise considerable expansion. Production is about three-fifths in the states not adjacent to the Great Lakes; some occurs in important lake cities. About one-half the exports (exclusive of those going to Canada) go out via New York, one-third via our Southern gateways, and one-ninth via the Pacific coast. The direct rail movement to contiguous countries on the south is noteworthy.

If we double the aforementioned tonnage to allow for expansion of exports we have 20,000 tons, of which possibly two-fifths, or 8,000 tons, could originate in the Great Lakes territory. Deducting one-half for shipments during the closed season leaves 4,000 tons, of which, in view of the location of our markets, the character of service required, and the competition of other routes, a fifth or about 1,000 tons, might use the waterway.

Canadian exports are small and appear unlikely to furnish any significant traffic for the waterway.

14. *Laundry machinery.* There are two groups of products here: commercial laundry machinery and equipment, and domestic washing machines. Of the former we exported an average of 2,400 in 1925-1927, while of the latter we exported

15,000 in 1925-1927. Some 1,800 tons of other laundry equipment also were exported on the average in the same years. Canada and Europe are our only important markets, accounting for 85 per cent or more of our exports. Australia and New Zealand appear to give promise of future development. Approximately two-thirds of the production of these products takes place in the Middle West, though in several instances at points back from the Lakes.

Power laundry machinery is sold very largely on special order and requires therefore rapid movement at irregular intervals. No use of the waterway is indicated.

Some of the manufacturers of domestic washing machines stock up to some extent abroad, at least in Europe. Such a practice favors use of a water route such as the St. Lawrence, for it permits the accumulation of large shipments. How far such a shipping practice might prevail would depend on the cost of carrying larger supplies abroad, the inconvenience of holding shipments back, of transferring from one method of shipment to another from season to season, etc. While none too certain that such use of the St. Lawrence route would develop, we set down, as a liberal figure, allowing for a large growth of exports, 1,000 tons of such traffic. Most of this would likely originate at Chicago, shipments from interior points in Illinois, Ohio, Iowa, etc., using all-rail routes to New York and other Atlantic ports for European business and these and Gulf and Pacific ports and gateways for shipments to the south and to the Far East.

In Canada, Toronto is the leading center of production for domestic washing machines. Three hundred tons per annum may be taken as a liberal estimate of Canadian exports of laundry machinery via the St. Lawrence.

We import none of these products and Canada's imports are almost wholly from the United States.

On this type of business, shipments to and from coast points would be distinctly rail movement.

II. Construction, Conveying, and Other Machinery

1. *Excavating and dredging machinery, concrete mixers, and other roadmaking and construction equipment.* Exports of these products averaged about 16,000 tons in 1925-1927. Production of these various items is chiefly in the states adjacent to the Great Lakes. On a liberal basis, three-fourths of the total can be attributed to that region. There is considerable production in Chicago, Milwaukee, Cleveland, and Toledo. Our best markets, as a rule, are to the south of us and in the Far East; over 80 per cent going to these regions. Omitting our exports to Canada, which flow over the border at Buffalo, Detroit, and elsewhere, the majority of these products went out through the port of New York. Exports to Latin America and to the Far East made extensive use of Gulf and Pacific ports.

If we start with the above 16,000 tons, increased 50 per cent to allow for growth, we have 24,000 tons of traffic to consider. Deduction of one-fourth for production in the East leaves 18,000 tons, of which one-half may be assumed to move during the closed season, causing a further reduction to 9,000 tons. Of this a considerable part would represent movements into Canada that would not require or permit use of the waterway.

When, next, we consider the character of service required, the advantages in using New York as a distributing point, and particularly the location of our markets, which are so situated as to make use of the St. Lawrence very unfavorable, as well as the fact that some of the production takes place at points requiring rail hauls that would encourage use of an ocean rather than a lake port, we conclude that an allowance of one-fifth of the above 9,000 tons, or about 2,000 tons, would be liberal. This would represent for the most part shipments that would be ready for movement about when a vessel making direct sailing was available from the Lakes and which did not require movement through a port where the buyer has his representative. Since service would be most frequent and delivery time

best in reaching Europe, the greater part of the tonnage mentioned above would represent shipments to that region.

The movement of products of the class under discussion to coast points by the waterway is wholly problematical. At the present time, though conditions most favor shipment to the Pacific Coast via Atlantic or Gulf ports, little is moving that way. In 1927 scarcely 60,000 tons of machinery (a very broad classification) moved intercoastally. The answer again runs in terms of delivery time and relative cost, all things considered. Some buyers might put up with inferior service for the sake of a small saving in transportation costs. An allowance of 1,000 tons of such traffic would be very liberal.

We import none of these products.

Canada's imports are almost wholly from the United States, though Great Britain sends her some. Her exports appear not to be large and much of the production is at Montreal or at interior points for which Montreal would be the natural shipping point. An estimate of 500 tons of traffic, one-half imports from England and one-half exports, would be ample.

2. *Conveying machinery.* Under this head are included cranes, hoists and derricks (except mining), elevators, and various types of conveyors. Cranes are produced predominantly in the lake states (especially Ohio and Michigan) and production of the other items is about evenly divided between the East and the Middle West. Exports in 1925-1927 averaged about 45,000 tons. Cranes are a minor part. Canada is a good customer, but as a rule Europe is not. Latin America and the Far East are our largest markets. This is likely to continue to be the case. Deducting exports to Canada, New York is used for from three-fifths to nine-tenths of the exports.

If we start with 67,500 tons of exports by the year 1940 (45,000 tons increased 50 per cent) and first deduct one-half for exports that would not originate in the lake states, 33,750 tons remain. We may again reduce this by one-half (because of the closed season), leaving approximately 17,000 tons. This in turn must be severely reduced to take account of the shipping

requirements of the industry, and for the location of our markets. Without attempting refinement, we should judge that at the most not more than 3,000 tons could profitably use the St. Lawrence route. Perhaps 1,000 tons should also be set down to allow for any coastal movements.

Canada appears to export none of these products and her imports are practically limited to those she receives from the United States.

3. *Mining and quarrying machinery (exclusive of oil-well machinery)*. Our exports of these products probably averaged 33,000 tons in the years 1925-1927. In general, our largest markets are in Mexico, Central and South America, Africa and the Far East, though Europe and Canada are also good customers, especially for coal cutters and rock drills. Production tends to occur in mining and quarrying or refining regions, indicating that many who engage in this line of production have no thought of other than a fairly local market. Ohio and Pennsylvania lead in production. Not more than a third of the production takes place in the states adjacent to the Lakes and there mostly at points back from the Lakes. From two-thirds to nine-tenths of our exports now pass out through New York, and much use is made of ports and gateways along our southern border. Some use is made of the Virginia ports and a little of the Pacific ones.

Applying the same reasoning used in connection with products heretofore analyzed, we first raise the aforementioned 33,000 tons by 50 per cent, or to 50,000 tons. We next make the assumption that one-third the exports would originate in the territory adjacent to the Lakes. Of these one-half would pass out during the closed season, leaving some 8,800 tons. When next we consider the advantages heretofore mentioned of using the port of New York, the use being made of the Southern ports for large exports to our southern neighbors, the need, in general, for frequent and expeditious service, and the difficulty any shipping line would have in working out a schedule of rates sufficiently low to draw traffic to the boats after an orig-

inating rail haul, we conclude that an allowance of 1,500 tons of this traffic would be liberal. Of this the greater part would consist of shipments to Europe.

We import none of these products.

There would be little occasion to ship such machinery to our coasts from interior points of production, since our coast regions do not, as a rule, carry on mining operations. It is possible that some stock shipments could move around in this manner and that such shipments might reach as much as 250 tons per annum.

Canada depends very largely on the United States for her mining and quarrying machinery. Much of her mining is done on or near her two coasts. To allow for any imports she might receive from England via the St. Lawrence, 250 tons of traffic will be set down.

4. *Oil-well machinery*. Our exports of these products averaged nearly 40,000 tons in 1925-1927. In the year 1927, nearly 85 per cent went to Mexico, Central and South America, and to the Far East and Africa. Europe and Canada took relatively little. One-half or more of the exports (other than those to Canada) pass out through New York and considerable use is made of New Orleans, the Texas gateways, and the Pacific ports. Maryland also figures more prominently than usual. About three-fourths of the production occurs in states not adjacent to the Great Lakes.

The reasoning used in the analysis preceding applies very closely here. Raising 40,000 tons by 50 per cent gives 60,000 tons, which must at once be reduced by three-fourths to take account of the points of production, and again by one-half to allow for the closing of the route, leaving about 7,500 tons of exports that might originate in the Lakes region during the open season. Recalling again the disadvantageous location of our markets from the point of view of using the St. Lawrence, the preponderant use of New York and the extensive use of our Southern gateways, it would seem liberal to suppose that

one-tenth of these 7,500 tons, or 750 tons, would find its way out over the St. Lawrence route.

Movements to the coast via the St. Lawrence would also be of limited extent. Stock movements to coast points near the Southern and Western petroleum districts might be made via the St. Lawrence in some cases. Perhaps 500 tons of traffic should be set down under this head.

Canada depends on the United States for her small imports of this class of machinery.

5. *Pumps and pumping machinery.* The products under this head range from steam pumps down to hand pumps. Exports of power pumps averaged some 30,000 in 1925-1927; of hand pumps, 100,000 in 1926-1927; of other pumps and pumping machinery about 2,500 tons in 1925-1927. In all, our exports may have amounted to 35,000 tons in 1925-1927, based on estimated average weights of the several items.

For the most part, this traffic requires frequent and expeditious transportation service. Some of the business is on special order and much moves in small lots. Production of power pumps is largest in the East; hand pumps are made extensively in the Middle West. Close to two-thirds of the exports move to Latin America, the Far East, and Africa, mostly via New York. Gulf and Pacific gateways are, however, used to a considerable extent. About a fifth moves to Canada.

Without attempting a refined analysis for so small an item as this, we may proceed as follows in arriving at an estimate of traffic available for the waterway. The above 35,000 tons may be increased by 50 per cent to allow for growth, giving 52,500 tons, of which at least half would originate in the East or in other regions not adjacent to the Great Lakes. Of the remaining 26,250 tons probably another half would move during the season when liner service would not be available, leaving 13,125 tons. Of this last amount, one-fifth, or about 2,500 tons, might be traffic originating at such points as could use to some advantage the service available on the St. Lawrence.

Canada depends almost entirely on the United States for this general class of products, and apparently has no exports.

No movement to or from our coasts via the St. Lawrence is indicated. The route is too roundabout, and savings, if any, would be too small to attract this class of traffic in significant amounts.

6. *Blowers and ventilating machinery.* In 1925-1927 we exported some 1,500 tons of these products. Canada was our best customer, taking more than a third of the total. Many are sold to the countries to the south of us and to the Far East. Production is about three-fourths in the Eastern states, principally Massachusetts and New York, with Buffalo, Detroit, and Chicago important points of manufacture. Some slight use might be made of the waterway for shipments from these cities, particularly the latter two. Such traffic could hardly exceed 100 tons per annum. Canada's exports are even smaller.

7. *Air compressors.* Our export of air compressors averaged 11,600 in number in 1925-1927. Production is predominantly in the East, particularly New York and Pennsylvania, and exports are likely to be made very largely from plants situated there. Canada and northern Europe are good customers, as are South America and the Far East.

Assuming 500 pounds to the compressor, there were in these years about 2,900 tons of this traffic, which we will increase, in accordance with our general assumption, by 50 per cent, or to 4,350 tons. It is doubtful whether more than a third of the exports, or 1,450 tons, would originate in territory adjacent to the Great Lakes. Deducting those that would go to Canada and those going West for export from Pacific ports, as well as those that would pass out during the closed season, leaves about 485 tons, of which as much as 250 tons might use the St. Lawrence route.

Canada's exports are extremely small and, as production for export is largely at Montreal, there would be little opportunity to use the St. Lawrence route.

III. Agricultural Implements and Machinery

This group of products is a very complex and diverse one. It will, however, be treated in the aggregate, as confusion would result from attempting to analyze separately each of its many parts.

There are at least three factors which tend to favor use of the St. Lawrence route for the movement of these products and also several factors adverse in character. The first of the favorable factors is the location of the industry. As would be expected, the manufacture of agricultural implements and machinery takes place chiefly in the Middle Western states. Illinois leads by a wide margin, with Wisconsin, Ohio, and Indiana following. New York alone of the Eastern states has a large production. The second favoring factor is that time is not always an essential consideration in the movement of these products, a considerable part of the shipments moving to warehouses in preparation for the rather marked seasonal demand. Time is highly essential, however, in the case of the special order business, such shipments generally moving on the mail steamers in order to get the quickest possible delivery. In the third place, the United States is favored as a producer of agricultural appliances and her foreign markets doubtless will continue a steady expansion.

Of the adverse factors the most distinctive is the season of production and export. The peak of production generally comes in January or February, with a gradual tapering off to a low point in August or September, when production begins to pick up. This simply means that the goods are largely manufactured in the winter months and shipped to the warehouse (domestic or foreign) in readiness for the spring and summer demand. This statement applies mainly to the Northern Hemisphere.[3] Shipments to the Southern Hemisphere, owing to the

[3] One large manufacturer has stated to us that only 15 per cent of his exports to northern Europe could take place during the open season. Others were equally certain that their products would have to move out when navigation is closed.

difference in the seasons, can move more largely during the season of navigation.

The location of our future markets is also likely to prove an adverse factor. Indications are that the percentage going to Europe will tend to decrease, and the percentage going to Latin America and the Orient will tend to increase. To these markets shipping accommodations will be least satisfactory. In making subsequent calculations, we shall assume that Europe takes one-fourth, Canada a sixth, and Latin America, the Far East, and Africa the remaining seven-twelfths. This is a slight decrease in the percentage going to Europe as compared with the average during recent years.

The third adverse factor is that agricultural implements are, as a rule, relatively high grade traffic which does not require the cheapest route, regardless of the service. Frequent and dependable liner service is desired for much of the traffic. Only exceptionally would the chartering of vessels for full cargo shipments be feasible.[4]

An important consideration is the exact location of the individual manufacturer in its bearing on the problem of getting shipments to shipside. Here detailed statistics are lacking. A directory of the industry shows that by far the greater number of manufacturers are situated some distance from any lake port; but, on the other hand, the larger plants, and particularly those producing for export, are located on or near the

[4] Evidence as to the type of service required is found in the slight use now being made of the rail and water routes which charge sub-standard rates and give sub-standard service. More than one manufacturer told us of being unable to use the inland water facilities now available, owing to the service they render being irregular, spasmodic, or otherwise unreliable; and to their not being "hitched up" into satisfactory through routes. Careful examination of the statistics indicates that only an insignificant use is being made of the Great Lakes for the movement, domestic or otherwise, of these products at this time. Some binder twine has moved recently, and occasional amounts of other products. Before the war there was a considerable movement from Lake Michigan points to New York via a combination lake-and-rail route. This has disappeared.

Lakes, notably Lake Michigan. It is important to remember, however, that a very large part of the export shipments of agricultural machinery move from the factory in "pool cars," which afford carload rates on miscellaneous shipments to a principal seaboard point, where the car contents are split up and dispatched by liners to various parts of the world.

Before passing to the final stages of this analysis it will be well to note specifically the present routing of our exports. As

ROUTING OF EXPORTS, AGRICULTURAL IMPLEMENTS, 1924

(In percentages)

Tools and Machines	Export Point			
	New York	Philadelphia Baltimore Virginia	Gulf-Arizona	Pacific
Plows	72	...	25	3
Harrows	82	2	13	2
Cultivators	72	17	8	3
Fertilizer distributors	73	....	22	5
Planters	78	6	15	1
Hand hoes and rakes	93	2	3	2
Mowers	81	14	2	3
Harvesters and reapers	60	31	8	1

would be expected, New York predominates as the point of export. The table above shows the ports used in 1924 for certain representative items. Exports to Canada are excluded in deriving the percentages.

The striking facts are the outstanding importance of New York, the large use of gateways along our southern border for shipments to Mexico, Cuba, etc., and the considerable importance of Philadelphia, Baltimore, and the Virginia ports. The Gulf ports are used also for the early business to South America, later shipments going from Northern ports.

There lie before us the difficult tasks of estimating what our future exports of agricultural implements and machinery are likely to be and what part of these might find it possible to use the St. Lawrence route.

We exported an average of 85 million dollars' worth of these products in 1925-1927, an amount considerably above pre-war exports but below those of 1919 and 1920. At an assumed value of $250 per ton, this would mean 340,000 tons of traffic. To allow for growth we will assume that by 1940 this figure will have become 510,000 tons, a 50 per cent increase. We have already assumed, as seems reasonable, that Canada will then be taking a sixth of our exports and Europe a fourth. Shipments to Canada will not require use of the St. Lawrence waterway as projected and so, deducting her portion, 425,000 tons remain for further analysis.

Taking next the 127,500 tons (one-fourth of 510,000 tons) going to Europe and making, to be liberal, no distinction between northern and southern Europe, our first problem is that of determining whether changes could be made in present methods that would permit a larger percentage of the bulk shipments to go out during the season of navigation. At the present time shipments begin to be put down in Europe in January, the stock being built up to meet the April to July demand. To use the St. Lawrence route before it closes it would be necessary to advance the period of production several months and to lengthen the period of carry-over correspondingly. It does not seem conceivable that our manufacturers would store from five to nine months in advance of sale or that there would be sufficient inducement for the foreign dealer to do so. The cost would be tremendous. To attempt to push the whole of the export business out during the last month or so of navigation would disrupt production schedules and put unwarranted emphasis on the saving of something in freights. Though the practice of extensive storage abroad undoubtedly would tend to cut down the present winter production peak, manu-

facturers have many other factors to consider, including the tying up of their capital, the granting of liberal discounts, and the determination of the demand abroad for a considerable period in advance. Domestic business makes up over two-thirds of the total, and thus dominates the production schedule. Since May to June delivery is required by the ultimate purchaser, production must as a rule correspondingly take place in the winter months. If we were liberally to assume that one-fourth of our exports could go out during the open season, it is doubtful whether more than a very few thousand tons would use the route, and then only on the assumption that shipments originate in or closely adjacent to the principal lake ports. Such traffic would be "occasional" in the sense in which that term is used in this study,[5] and therefore will not be included in our final estimate.

There remain the 255,000 tons of traffic (one-half of 510,000 tons), which we assume will go to points south of us and to the Far East and Africa. Of this traffic we shall consider first the export movement (estimated at one-third of the total) which takes place in the late winter and early spring months before the St. Lawrence is open.[6] Owing to the likely infrequency of liner service and to the delay in getting it under way, coupled with the very moderate saving, if any, on rates and all other costs, it would appear likely that relatively little of this early season business would be held back for shipment via cargo liners out of Great Lakes ports. It is possible, however, that a very few of the large companies could make full cargo shipments, if not to one country alone, then to adjacent countries. The only section which could receive such large shipments would be perhaps the east coast of South America and, more rarely,. Australia and Africa. Mexico, always a very large

[5] We have assumed, to be on the safe side, a saving in freight charges. This might not eventuate, at least to some destinations.

[6] We are informed that exports to these regions are of very small extent from the end of October to the first of January.

customer, will continue to get her supplies directly by rail without rehandling from factory door to destination point. Prediction is exceedingly difficult, but we shall surmise that early season exports via the St. Lawrence, liberally estimated, would not exceed 25,000 tons per annum.

There remain about 170,000 tons (two-thirds of 255,000 tons) of annual exports which may be expected to go to points to the south of us and to the Far East and Africa during the season from May to the close of October. We first may deduct at least a fifth to account for shipments originating at points in the East, leaving 136,000 tons. In consequence of the infrequent shipping service to the Southern Hemisphere and the Orient, it would be necessary to hold shipments back and to undergo a considerably longer delivery time once the vessel gets under way than if New York or some other coast port were used. But, as was stated at the outset, delivery time is not always an important consideration in the routing of this traffic. If shipments are held back for the boats, then we can properly include the traffic that goes in that way in our estimates.

It is our best judgment, based on a consideration of present rail rates to various coast points and ocean rates therefrom, of the rates which vessel lines into the lakes doing a rather infrequent business would have to charge to conduct their business at a profit, and of the incidental additional costs of getting shipments to shipside, that at the most the saving would not be sufficient to induce the shippers to effect a large reorganization of sales and shipping methods. We conclude, therefore, that the use which might be made of the route would be small in extent and "occasional" in nature, and we therefore make no allowance for it on our final estimate.

On the other hand, the large shipper, having a broad line of products and making large shipments to certain principal countries, might find it advantageous occasionally to place a charter or part charter. There might, on a liberal estimate, be 25,000 tons of such traffic in the summer months. The figure can not

be placed higher because of the importance of special order business and because of the strain that would be put upon the manufacturer to accumulate even a part of a shipload for a single destination or a limited range of destinations. The bulk of the summer shipments will continue to use the coast ports.

Canada must now be brought into the picture. Her imports from countries other than the United States are small and mostly limited to the lighter products. It is conceivable that as much as 500 tons of these imports could move into Canada via the St. Lawrence. In the years 1925-1927 Canada exported (to countries other than the United States) an average of 45,000 tons of agricultural implements and machinery (assuming $250 as the value per ton). Production is largely in Ontario and Quebec and in many cases is in the hands of companies affiliated with our large American companies. A detailed analysis will not be attempted. Assuming a 50 per cent increase of such exports in 1940, or to 67,500 tons, and that conditions relative to the seasons and the like are about the same as they are with American manufacturers, we can roughly estimate that one-ninth of her exports (the proportion of the American total that would use the St. Lawrence route), or let us say, 8,000 tons, would find it advantageous to use the waterway.

There remains for analysis only the trade with our own coasts, particularly the Pacific. The big consideration in this connection is the seasonal element. Movement of the products to local points for delivery upon the coming of spring requires shipment during the season when navigation is closed on the Lakes. The bulk of the shipments would go at this time, precluding, therefore, the use of chartered vessels with their capacity to carry large quantities at low rates. Shipments during the open season would be relatively light and would require regular and frequent liner service. Such is not likely to be available, and this fact, taken together with the roundaboutness of the water route and the quick, easy, and regular delivery possi-

ble by rail, makes it seem altogether unlikely that any significant amount of traffic would use the water route. In fact we find it difficult to see how any traffic, other than possibly some that is "occasional" in character, could use the route to advantage.

IV. Electrical Machinery and Apparatus

This group embraces a wide variety of products. For convenience, three general heads will be used: generators, motors, and all other.

1. *Generators.* We exported in the years 1925-1927 an average of 3,750 of the smaller direct current generators (under 500 kilowatts capacity). Of these, considerably more than half went to Canada. As a rule, Europe is not an important customer. Exports of the larger direct current generators averaged only 52 in number in 1925-1927. Of these three-fourths went to Latin America and the Far East. The same markets in general are found for our alternating current generators, our exports of which averaged about 365 in 1925-1927. Some 800 steam-turbine generator sets and 4,500 self-contained lighting outfits also were exported on the average in these years. For the most part, Latin America and the Far East are our best markets. Our total exports of generators averaged something like 25,000 tons in 1925-1927.

All of these products require expeditious movement; particularly true is this of the large units, usually built to specification or at least on special order. The smaller generators are more of a stock proposition, but even they are not a class of traffic that can move leisurely. Production of generators appears to be somewhat evenly divided between the East and the Middle West, though probably most of the large generators are produced in the Eastern states. The peak of production in the case of electrical goods in general appears to come in January, with a comparative slump in the summer and early fall months.

Basing our calculations on 25,000 tons, the average of the years 1925-1927, and allowing a 50 per cent increase by 1940, we have 37,500 tons of future traffic for analysis. The latter figure we can reduce by at least one-fourth for exports to Canada and again by 50 per cent for production in the East, leaving 14,000 tons. One-half the latter figure in turn may be deducted for exports during the season when liner service would not be available, leaving 7,000 tons. It happens that some of the large manufacturers are conveniently located for a direct all-water export movement and others might be able to work out rates and service that would be advantageous, when available. On a liberal estimate, a third of the above amount, or, let us say, 2,500 tons might use the St. Lawrence route.

2. *Motors.* There are several sub-classes of products to be distinguished here; small motors (under 1 H.P.), motors from 1 to 200 H.P., motors over 200 H.P., and railway motors. With the exception of the first class, of which Canada took two-fifths in 1925-1927, our best markets are in Latin America and the Far East. Europe as a rule takes few of our motors. Production of an export class of motors appears to be about two-thirds in the Eastern states, and a very considerable part of the remainder takes place at points not immediately adjacent to the Great Lakes.

In all, we can estimate our exports of motors, including accessories and parts, in 1925-1927 at about 14,000 tons per annum, or, deducting those going to Canada, about 10,500 tons. This figure will be raised by 50 per cent, or to 17,750 tons, to allow for growth. This we shall reduce by two-thirds to allow for production in the Eastern states, leaving about 6,000 tons, and this in turn must be reduced 50 per cent to allow for movements during the period when liner service would not be available, leaving 3,000 tons. In view of the location of our principal markets and of the points of production in the lake states, we conclude that not to exceed 750 tons of motors and accessories would find it advantageous to use the St. Lawrence route.

3. *Other classes of electrical apparatus, equipment, and supplies.* It will simplify matters if we eliminate those products which clearly would not use the St. Lawrence route. Such, for example, are electric locomotives (produced in the East or at other points where use of the water route would be unlikely), incandescent electric lamps (which are produced extensively along the Eastern coast and go almost exclusively to the countries to the south of us and to the Far East), and such small items as lighting sockets and receptacles, which are produced predominantly in the East and at best account for very little tonnage. There remain perhaps 100,000 tons of traffic, liberally estimated, of which transformers, storage and other batteries, and switches and switchboards constitute the greater part. Approximately two-thirds go to Latin America, the Far East, and Africa, and, on the average, a fourth to Canada. Production is, of course, widely scattered, with the East standing out very prominently, as well as many inland Middle Western cities—St. Louis, Cincinnati, Dayton, Chicago, Cleveland, Toledo, Milwaukee, and Detroit. It is to be noted, though, that concerns having both Eastern and Middle Western plants tend to use the former for their export business. Thus the principal manufacturer of electrical equipment in Chicago has recently completed a plant in New Jersey which can take care of much of its export business. Canadian and European branches of American manufacturers also take care of much of the demand in those countries.

To follow through each item of traffic separately would involve us in unprofitable detail. It is better to base our conclusions on a knowledge of the kind of transportation service it requires. Electrical equipment constitutes a distinctly high grade of traffic. The industry is progressive and highly competitive and puts great emphasis on "service," which, from our viewpoint, spells rapid and certain transportation service. Our markets are distinctly off the one natural trade route which the St. Lawrence waterway might hope to evolve—

central United States, the United Kingdom, and northern Europe. Much of this traffic would, therefore, continue to flow through Southern and Pacific gateways, and New York, now the dominant port of export, would continue to draw the bulk of the shipments.

If we start with the aforementioned 100,000 tons of traffic and increase it 50 per cent to allow for growth in the next decade or so, we have some 150,000 tons of traffic to consider. If only one-fifth is deducted for exports to Canada, 120,000 tons of traffic remain. It is our judgment that at least three-fourths of this traffic would originate at points from which the St. Lawrence route could not be used to advantage. There are left, however, 30,000 tons of export traffic to originate principally at Chicago, Milwaukee, Detroit, Toledo, and Cleveland. But of this, probably one-half would require movement during the period when liner service would not be available, leaving, therefore, 15,000 tons. It is possible that a fourth of the above 15,000 tons of traffic would make use of the St. Lawrence route. Since adjustments of production and sales methods would be required, the figure we obtain, 3,750 tons per annum, represents really a maximum under the most favorable conditions likely to prevail. This traffic would consist for the most part of the heavier, low value goods. Small amounts of "occasional" traffic might also move, but this does not enter into the reckoning.

We do not see any likelihood of a "coastwise" movement to our Atlantic, Gulf, and Pacific Coasts taking place. The route would be too roundabout and time-consuming for this type of traffic.

Our imports are of slight extent and consist largely of incandescent electric lamps obtained from Europe and Japan. We foresee no use of a deep waterway for this class of imports.

Canada's exports of electrical apparatus and supplies are limited; in fact, her total production does not equal in value the exports of the United States. Canada's exports to coun-

tries other than the United States average but little more than a million dollars. The most liberal estimate would not put the use of the waterway for such traffic at more than 500 tons per annum.

Canada draws the bulk of her imports from the United States, only 10 to 15 per cent coming from the United Kingdom and other sources. Some of these come in at Pacific ports and a large part would continue to use Montreal as the most advantageous point of entry. However, it is possible that as much as 500 tons of import traffic would develop.

V. Engines

1. *Steam engines.* Two important factors detract greatly from the possibility of using the proposed St. Lawrence waterway for exports of steam engines, namely, the predominance of production in the East, and the fact that our markets are in regions least advantageously reached via the St. Lawrence. Close to two-thirds of the production of steam engines of all classes is credited to the East, particularly Pennsylvania and New York. Europe is a very limited market for our products, our largest sales being made in Latin America and the Far East, with nearby Canada also important.

Take steam locomotives, for example. There are only three companies to be considered. Of these, two are in the East, and the third, in north central Ohio, could find little inducement to send its export locomotives north to Toledo or Cleveland for the intermittent vessel service that might be available from there. It could about as cheaply send its products to New York or other ports where the service would be vastly superior. It is also doubtful whether the large cranes and appliances necessary for placing locomotives aboard ship would be available at the lake ports. Clearly, no significant use of the waterway could be made in the case of locomotive exports.

About 70 per cent of our exports of stationary steam engines, including marine engines and mechanically-driven turbines, go

to Latin America and the Far East, with Canada taking much of the remainder. What has been said about steam locomotives applies in large part here. Business is done almost entirely on a special order basis, with much of the construction according to the purchaser's own specifications. When completed, orders generally must move with rapidity and according to the foreign purchaser's wishes. Assuming that there would be a small amount of vessel service between the Great Lakes and Latin America, some little use might be made of the waterway as on shipments originating at Milwaukee. However, with total exports averaging only about 25,000 tons in 1925-1927, and with deductions for production at points from which the St. Lawrence route would not be available, for shipments during the closed season, shipments moving to parts of the world to which there would be no direct service from the Great Lakes, shipments that would go all-rail to contiguous countries or to Gulf or Pacific ports for transshipment, and shipments that must move with all possible expedition, there might be left, to go via the St. Lawrence, 2,000 tons of exports per annum. To allow for growth we might increase this estimate to 3,000 tons.

Closely related to the foregoing are various accessories and parts, including boilers,[7] air-brake equipment and mechanical stokers, condensers and heaters, and such appliances as injectors, gauges, etc. In all, our exports of these items probably averaged about 15,000 tons in the years 1925-1927. At least a fourth of these passed into Canada and an equal or larger amount into contiguous countries on the south, including Cuba, which would be reached all-rail.[8] A considerable part passes out through Pacific gateways. Much of the business is of high class, moves in small quantities, and requires quick and dependable service. As a rule shipments are not made to build up stocks abroad, but cover sales on special order, for which specified deliveries are required.

[7] Heating boilers have been treated elsewhere.

[8] As noted previously, railway cars move from Florida to Cuba by car ferry.

When all these factors, in addition to those enumerated in discussing engines, are considered, it can be seen that relatively little use could be made of the St. Lawrence route. However, it is possible that some irregular shipments, particularly of the lower value products mentioned, could utilize the deep waterway. An estimate of 1,500 tons per annum, in which allowance for growth of total exports is made, would be liberal.

Imports under all these heads are either negligible or non-existent.

Trade between coast points within the United States is likely to continue to be all-rail. The lower value products (such as boilers) tend to be marketed within a rather limited zone, while the higher value ones require a better type of transportation service than could be available via the St. Lawrence.

Canada's exports of the various products thus far considered have been of very small extent in recent years and in some cases are non-existent. A considerable part goes to nearby Newfoundland. Canada's imports are very largely from the United States and so have already been accounted for. The remainder come almost wholly from the United Kingdom.

As has frequently been pointed out before, Canada's greatest industrial area is lower Ontario, a fact which suggests the likelihood that the St. Lawrence would mean relatively more to Canada than to the United States so far as shipments of manufactures are concerned. Assuming that Canada's overseas exports of the products we have been considering will increase, we might set down, as a liberal estimate, 750 tons of export traffic via the St. Lawrence. Likewise, her imports from abroad via the St. Lawrence might reach about 300 tons. Both figures are liberal.

Domestic movements within Canada are likely either to be all-rail or to go between points (particularly Ontario and the West) that would not involve use of the St. Lawrence proper.

2. *Internal-combustion engines* (*other than automotive*). Engines for automobiles, tractors, and aircraft are treated elsewhere. The items to be discussed here, in addition to the

ordinary internal combustion engine, used for a great variety of purposes, are Diesel and semi-Diesel engines and various types of marine engine. Our exports (in thousands of dollars) have been as follows in three recent years:

	1925	1926	1927
Stationary and portable engines:			
Diesel and semi-Diesel	1,289	894	684
All other	31,112	36,199	31,747
Marine engines:			
Diesel and semi-Diesel	291	1,009	720
All other	6,441	8,312	9,495
Engine accessories and parts	4,111	4,273	3,219

As a whole, Europe is not an important market. Canada, as would be expected, is a large market, and the Far East figures more prominently than usual. Production of stationary and portable engines, other than Diesel, is very largely in the Middle Western states adjacent to the Great Lakes; that of marine engines is about evenly divided between the Middle West and other parts of the country; and that of Diesel engines is largely in states other than those adjacent to the Great Lakes.

With the exception of the ordinary internal-combustion engines, these products move under the same conditions as steam engines and the considerations indicated there need not be repeated here. Internal-combustion engines are a standardized product sold in considerable part in the same way as agricultural implements and machinery. Our exports of these various products have averaged perhaps 30,000 tons in recent years. Weighing all the factors enumerated elsewhere in discussing similar traffic, an estimate of 2,500 tons of traffic per annum for this entire group of products would appear liberal. To allow for growth, this is increased to 5,000 tons.

Our imports are of very minor extent.

For explanation of reasons for expecting domestic trade to continue to move all-rail, see the foregoing discussion of movement of steam engines and discussion elsewhere of movements of agricultural implements and machinery.

Canada's exports of internal-combustion engines are only a small fraction of those of the United States. It would take many years for use of the St. Lawrence route to amount to 500 tons per annum. Imports are almost wholly from the United States. Any use that might be made of the waterway would be of negligible extent.

3. *Water wheels and water turbines.* Exports of these products are akin to those of other large power units, such as steam locomotives. Sales are on a special order basis, and shipments must move promptly and must reach destination for promised delivery. Canada accounts for nearly half of our exports; Europe takes almost none. Production is largest in Pennsylvania. Considering all these factors, it will be seen that any use that might be made of the St. Lawrence route would be of the most irregular, unpredictable character. At least it would be small from a tonnage standpoint.

Canada appears to export none of these products. In most years her imports come from the United States. Some have come in recent years from the United Kingdom and Switzerland. Bearing in mind the small extent of these imports, the general location of the nation's water power resources in the eastern part of the country, particularly Quebec, the closed season and other limiting factors, it appears likely that no use, or at least only a very slight use, could be made of the St. Lawrence waterway.

VI. Vehicles

Automobiles. In several essential respects conditions favor the use of the St. Lawrence waterway for the movement of automobiles. Production is preëminently in the states bordering on the Great Lakes, exports at present are increasing with considerable rapidity, and the industry is likely to attach more and more importance to the export market in years to come. It will be necessary, therefore, to examine, with great care, trade, manufacturing, and shipping practices to see wherein they may favor or limit the use of the St. Lawrence route for this type of traffic.

a. *Growth of exports.* Exports of automobiles and parts from the United States have grown tremendously in the last eight years, as shown by the following table:

EXPORTS OF AUTOMOBILES, 1919-1927 [a]

Year	Passenger cars (Number)	Trucks (Number)	Parts (Value)
1919	67,145	15,585	$42,562,186
1920	142,508	29,136	86,198,013
1921	30,950	7,480	39,058,729
1922	66,790	11,443	38,298,032
1923	127,035	24,861	58,974,907
1924	151,379	27,351	73,759,406
1925	252,124	60,116	86,943,913
1926	245,443	68,174	105,128,015
1927	286,088	107,031	118,692,707

[a] Data taken from *Facts and Figures of the Automobile Industry*, 1928, p. 54.

Distribution of exports. The summary below for the year 1927 shows the distribution by major geographic regions.

GEOGRAPHIC DISTRIBUTION OF AUTOMOBILE EXPORTS, 1927

Region	Passenger Cars		Trucks and Buses		Total	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Europe	79,857	28.7	25,482	24.2	105,339	27.4
Canada	34,300	12.3	4,253	4.0	38,553	10.1
Mexico, Central America, Cuba, West Indies, etc.	12,559	4.5	3,971	3.8	16,530	4.3
South America	58,488	21.0	26,865	25.5	85,353	22.2
Australia and New Zealand	46,346	16.6	25,533	24.2	71,879	18.7
Far East	18,955	6.8	4,135	3.9	23,090	6.0
Africa	22,327	8.0	5,624	5.3	27,951	7.3
All others	5,910	2.1	9,594	9.1	15,504	4.0
Total	278,742	100.0	105,457	100.0	384,199	100.0

Our largest markets are in the countries to the south of us and in the Far East. Europe accounts for only about a quarter of our exports. This fact is of fundamental importance.[9]

The distribution table does not give a precise picture of the situation, for these exports go to over a hundred different countries and into nearly every nook and corner of the world. It is also important to bear in mind that the shipments to any country are split up between many manufacturers and many consignees, and are spread out over the year. A representative manufacturer's daily export sheets will show, not a large number of cars going to a single destination, but a great many moderate sized and small shipments going to a wide scatter of countries.

Deducting exports to Canada, about 85 per cent of our exports of cars and 80 per cent of our exports of parts went out in 1924 via New York.

b. *Period of export*. Assuming that the season of cargo liner service would extend from early in May till the middle of November, the following percentages of total exports have gone out during the closed season:

	Passenger Cars	Trucks	Accessories and Parts
1923	56.3	58.3	54.3
1924	52.0	53.0	48.8
1925	54.4	53.6	55.1
1926	49.3	52.2	49.5
1927	52.7	52.1	54.0

We shall not be far off if we assume that one-half the automobile exports at the present time go out during the season when vessel service would not be available. For reasons given

[9] An increasing proportion of the exports of American cars are assembled abroad, and of course exports to Canada would be greater were it not for the location of branches of American factories there. The rapid development of good roads in non-European countries will have an important effect on the market for cars. South America in particular, with her petroleum resources, promises to become a large market.

later, this percentage is more likely to increase than to decrease.

c. *Present methods of routing.* At the present time, the question of routing appears to turn very largely on the desires and needs of the foreign purchaser (hereafter designated as the dealer). The dealer as a rule does business on a credit basis and dislikes to have his money tied up in cars any longer than necessary. He is also careful about over-stocking, owing to frequency of changes in models. He therefore wants delivery in the quickest possible manner and puts the savings of a few days in delivery time above a possible saving in transportation charges. His sales also often depend on ability to make quicker delivery than his competitor can. Buying f. o. b. factory, the dealer has a voice in the routing, and this he usually exercises.[10] Considerations other than freight rates are, then, of controlling importance at the present time. Sometimes these are matters of national pride or policy, a British dealer directing that a British boat be used. Also there are cases in which a foreign merchant entrusts to an American broker the purchasing of a number of items, automobiles among them, which are collected at a common point for consolidated shipment.

Closely related to the foregoing is the fact that, for convenience, the various banking and shipping arrangements incident to an export order can best be taken care of at one great point of export. Thus, practically all the companies doing a large export business maintain export departments in New York City in close conjunction with the banking houses and brokers there.

d. *Shipping practices.* Passing next to shipping practices, we find that business will seek that port affording the most frequent and most varied sailings. This port is now and probably

[10] The traffic manager of one prominent manufacturer states that 90 per cent of their cars are shipped the way the dealer directs. Routing to seaboard is, of course, largely the manufacturer's problem, but his options are few.

always will be New York.[11] It is also a matter of controlling importance that the manufacturer can consign his entire day's output of export cars in a single shipment or a limited number of shipments to his representative at the port for breaking up and dispatch by various vessels there. So great is this advantage that it is certain the manufacturer would be very reluctant to give it up, particularly as any alternative arrangement would be available only during the season of lake navigation.

e. *Manufacturing practices.* The manufacturer operates on the basis of a rapid and exacting production schedule and abhors anything that makes for irregularity of production. It may be presumed, therefore, that he would discourage any serious disturbance of his production routine just to enable shipments to go out from the Lakes by the occasional boat likely to be available there. He does not practice storage; cars move out as fast as they are produced. While a few days' foreign orders might be held back, either in production or after, as a matter of accommodation to the dealer desiring to ship direct by boat, more than this would so seriously disrupt the manufacturer's domestic shipments that he would oppose the practice vigorously.

f. *The possibility of change in transportation requirements.* We do not wish to imply by what has been said above that none of the practices mentioned can be changed or that the American producer is not interested in getting his cars into the hands of the foreign dealer as cheaply as possible. Since our analysis is as of approximately 1940, it becomes necessary, before we go further, to appraise certain fundamental aspects of the automobile industry to see what, if any, changes in its transportation requirements may impend.

Two forecasts seem to be justified: one, that medium and high priced cars will continue to demand the best type of

[11] Nearly 90 per cent of United States exports of automobiles, exclusive of exports to Canada, have left via New York. For a convenient summary of points of export related to the states where the shipments originate, see Gregg and Cricher, *Great Lakes-to-Ocean Waterways,* 1927, pp. 124-129.

transportation service in order to meet the competition of other cars, foreign and domestic, to enable the foreign dealer to release his capital in as short a time as possible, and to protect against changes in models and in price; two, that in case of low-priced cars there is some possibility that the industry will reorganize its export methods, presumably through the manufacturers carrying cars in stock abroad. If this were done cars would not have to move so expeditiously as at present; they would go in larger lots; and transportation costs would enter more largely into the determination of their routing.

Of the twofold problem thus presented to us—what effect the St. Lawrence waterway might have on the routing of low-priced cars and what effect it might have on the routing of all other cars—we shall consider the latter part first.

Recalling the earlier discussion of present methods of exporting, it is clear that the advantage of using some other method of handling export shipments must be a very considerable one before the present closely dovetailed, expeditious, and efficient ones will be given up. Could there be sufficient advantage in using the St. Lawrence route to outweigh the manifest advantages of continuing to use present methods? So stated, the problem becomes one of service and costs.

g. *Service comparisons.* There are two problems here: the frequency of service, and the relative delivery time by this route compared with that by other routes. As to frequency, for reasons developed elsewhere we regard it as unlikely that anything approaching the frequency now enjoyed at New York would be available from the Lake ports, even to Europe.[12] At

[12] Bearing on this question of frequency of service is the likely use to be made of the St. Lawrence route by the large shippers of low-priced cars. It is a matter of record that the Ford Motor Company intends to make as full a use of the St. Lawrence route as is possible. What is forgotten, however, is the fact that this company will make extensive use of its own boats, a practice which will make it the more difficult for liner service to develop. Any concern which can ship in cargo lots is in an altogether different class from those depending on common-carrier service.

the present time the railroads afford second morning delivery from Detroit to New York, and Tuesday's shipments, for example, may clear New York harbor the following Saturday or Monday. It is unlikely that, of two shipments made at Detroit at the same time and having the same destination, one sent via New York and the other via the St. Lawrence, the latter would have gone half as far toward destination as the former in the four to six days it takes it to clear from New York. Owing to the inability to make complete loadings at any one lake port, the liners would have to make successive stops at other ports on the way out, not to mention delays due to restricted navigation or to the roundaboutness of the St. Lawrence route.[13]

h. *Comparative rates.* The rates on assembled cars, boxed for export, and on parts, from typical shipping points to New York are as follows:

RATES ON ASSEMBLED CARS AND PARTS

(Cents per 100 pounds)

To New York	Assembled cars [a] (Boxed for export)	Parts [b]
From:		
Detroit	82½	44
Flint	93	49
Lansing	96½	51½
Kenosha	106	56½
South Bend	99½	53
Indianapolis	98½	52½
Toledo	82½	44
Cleveland	75	40
Buffalo	58	32

[a] Minimum weights: commonly 15,000 to 24,300 pounds, depending on length of car. The minimum weight requirement does not usually give trouble. Export cars, being boxed, use flat cars and usually load to requirement.

[b] Representative rates. Minimum weights: 24,000-30,000 pounds and up.

[13] See Chapter IV.

These rail charges would be saved if the St. Lawrence route were used, but certain alternative costs would be incurred: an increased ocean rate, the cost of getting cars to shipside, and certain miscellaneous costs, such as added insurance, the expense of adapting output to infrequent service, etc. The ensuing discussion will be limited for the most part to the two first named.

No one is in a position to judge with any accuracy what the relationship between New York rates and lake rates would be. The greater the volume of traffic, the lower the rates could be; the greater the frequency and dependability of service, the higher the rates could be and yet draw traffic from other forms of transportation. To say that rates to northern Europe would have to be only 25 per cent higher than those from New York and 50 per cent higher to other destinations, is to be quite liberal in judging the handicaps of the St. Lawrence route.

The going ocean rate, New York to United Kingdom ports, on boxed automobiles weighing up to 4,480 pounds is 16 cents a cubic foot. On a small-sized car, weighing approximately 2,600 pounds boxed, occupying 273 cubic feet of space, the present ocean rate from New York is $43.68. From Detroit this rate, increased 25 per cent, is $54.60. The rail rate, Detroit to New York, on such a car is $21.86, making a combined rate via New York of $65.54. The difference between this and the all-water rate is $10.94. On a car weighing about 3,600 pounds the difference would be $15.00. There is, however, the cost of getting the car to shipside at Detroit, a cost which is not incurred on shipments via New York.[14] This could not be less than $7.50 per car. The difference would then be from $3.50

[14] A figure as high as $14-$15 per car for trucking to the public dock has been given us. This cost would depend on the distance, of course, and the figure given doubtless is high. It is to be borne in mind that one large car, boxed, is all a truck can carry. Switching charges in all the lake cities appear to be on the increase; particularly would this be the case if the railroads were called upon to turn the traffic over to a rival form of transportation.

to $7.50 per car. When increased insurance charges and the expense of adjusting shipping orders and banking arrangements to the irregular and seasonal service which would be available via the St. Lawrence are taken into account, the differences last indicated would be materially reduced and perhaps entirely wiped out.

We may next consider the possibility of a saving in transportation costs on automobile exports originating at points not on the Lakes. Certain representative rates from such points are

DOMESTIC RATES ON ASSEMBLED CARS, NOT BOXED, AND REPRESENTATIVE RATES ON PARTS

(Cents per 100 pounds)

Interior and Lake Points	Distance (Miles)	Assembled cars [a] (Unboxed)	Parts [b]
Lansing and Detroit	87	60½	19½
Kenosha and Chicago	52	51½	16½
Kenosha and Milwaukee	33	31½	14
Indianapolis and Chicago	184	78	25
Indianapolis and Toledo	225	82½	26½
Indianapolis and Detroit	276	87	27½

[a] Minimum weights: 10,000-16,200 pounds.
[b] Minimum weights: 24,000-30,000 pounds.

given above. The rates shown are applicable to unboxed cars, rates not being available for boxed cars between such points.

Quite evidently, by the time the rail rate from interior points to lake port was paid a serious cut into any advantage of using the St. Lawrence route would be made. Thus, from Lansing to Detroit the rate is 60½ cents and from Lansing to New York, 96½ cents, a difference of 36 cents. On parts the difference would be 32 cents. From Indianapolis to Chicago the rate on cars is 78 cents and to New York, 98½ cents, a difference of 20½ cents; to Toledo the rate is 82½ cents, giving a difference of 16 cents under New York, and to Detroit, 87 cents, a difference of 11½ cents. In fact computations similar to those made

above indicate that on shipments originating at Lansing, Michigan, there would be no saving, but in fact a loss of about $2 on both the small and the larger car.[15] Conditions here are more favorable than they would be in the case of any other city shown in the last table above.

It has been suggested that it might be cheaper to drive the cars under their own power to the ports, boxing them there. The maximum economical driving distance has been set at 150 miles, representing six hours of driving at a safe speed for new cars of 25 miles per hour. It has been said that 80 per cent of the production takes place at points within driving distance of the ports. Analysis indicates that this method would not be efficient. Manufacturers could, of course, contract for the driving service, there now being so-called " drive away contractors " for domestic shipments. It would not seem likely, however, that the cost of this service, plus the added cost of boxing at the port over the cost of boxing at factory, plus a truck haul (presumably) from point of boxing to the public dock, would be less than the cost of direct rail shipment.[16]

Should it become possible to ship unboxed cars in export, as is now done in the case of domestic rail shipments, the difficulty of this method of getting cars to shipside would be considerably decreased. One of the most prominent manufacturers has done some pioneering work in this field. What are the possibilities along this line?

There can be no doubt that boxing is costly, causes delays and inconvenience, and in some cases involves paying a duty on the box itself. There are said to be a thousand feet of lumber in

[15] Rates on motor trucks are somewhat lower than those given above (though with higher minima), but there is no reason to believe the relationship of rates would be any different from that outlined above.

[16] We assume each manufacturing concern would have to provide at the port its own facilities and men to do the boxing. These facilities would be in use only during the season of navigation and intermittently even then. The whole idea of boxing at port seems to be an impractical one.

the box required for a large passenger car. A method of shipping by boat without boxing has been worked out and is said by its inventor, who devised the system of shipping cars by rail unboxed that is so extensively used, to make possible quicker loading and unloading, without interference with bottom loading, which, it is said, may be made either before or after the automobiles are put in place.

It would, of course, be cheaper by this method to get cars to shipside and loaded than it is now, particularly in the case of cars manufactured at the important lake ports, but use of this device requires not only the education of the ship owner but the provision of certain facilities in the boats which could be used for no other purpose. A change in boat design would also be advantageous. But it is unlikely that owners generally would equip vessels in the manner required. For all these reasons it is doubtful whether this method of shipping would come into very great use for the export trade. The seasonal closing of the St. Lawrence route also tells against vessel lines fitting themselves for this service. Everything points to the use of such a device, if at all, in the trade with our own coasts. We will take it up again under that head.

Our conclusions as to rates and service are as follows: first, that the service requirements of this class of automobile traffic would not in most cases be met by the service available; and, second, that there would be no saving, in the case of cities not directly at the principal lake ports, and that even in the case of shipments originating directly at the ports the local trucking cost, as well as the incidental costs referred to above, would constitute a very considerable, in some cases a complete offset, to the apparent saving arising from the substitution of an "all-water" rate from the Lakes for a "rail-and-water" rate via New York or other ocean port. Whether viewed from a service or a rate standpoint, then, there appears to be relatively little in the St. Lawrence route for export shipments of medium and high-priced cars.

Let us consider next the low-priced car. In this field there is the possibility not only of savings of the sort that may be realized in the case of the medium and higher priced cars, but also of additional economy through shipment in cargo lots, provided the marketing system were so reorganized that manufacturers could carry stocks of finished cars abroad. Would manufacturers of cheap cars, given water transportation, carry stocks abroad?

The advantages that would follow from the adoption of a policy of carrying stocks abroad are, first, the ability at all times to make immediate deliveries to dealers there, and, second, the saving in transportation and related costs, secured partly through shipping in much larger units than now and partly through using an inferior type of transportation service. Off-setting costs are: (1) those of warehousing, including extra handling and insurance; (2) those of having capital tied up in large amounts and in distant places, as contrasted with the "cash" business done today; (3) the disruption of manufacturing schedules in order to get out large export shipments, though if these orders could be worked out during the "off" season this disadvantage would become an advantage; (4) the danger of over-stocking, making it necessary to sacrifice stocks unsold when new models are coming onto the market; and (5) the fact that in at least some cases there would be added movement in getting the cars into the hands of the dealer; that is, whereas cars may move today direct to dealers in large and moderate sized places, in the event of the change we have indicated there would be a direct movement to warehouse and a second movement to dealers at points served from the warehouse.

The analysis of rates hitherto presented, which was not in terms of full cargo shipments, showed that the saving per car would be small, in many cases insignificant. Would the saving incident to using the St. Lawrence waterway for stock shipments be enough greater, considering the advantages and

disadvantages listed, to induce the reorganization we have indicated? It is to be borne in mind, in answering this question, that on low-priced cars small absolute savings figure more prominently than do much larger absolute savings on high-priced cars.

Before answering this question one important fact should be before us. Bearing on item (3) above, the stocking up abroad would be likely to take place largely during the winter months, as is the case in the domestic field, for this is the time when the manufacturer finds it most difficult to keep his plant running on an efficient basis and when new models are being worked up for the trade. With the St. Lawrence route not open on the average till the end of April, it can be seen that the manufacturer would be forced to use other routes on the largest part of his "stock" shipments. The idle period during the early summer months could not be filled in with stock export orders, for usually changes in models are then pending. Only in the late summer or early fall months could cars be got out in quantities for exportation, but this is a period when the manufacturer is crowding production for the domestic markets.[17]

Quite apart from these seasonal limitations, it would be difficult to induce the manufacturer of low-priced cars to undertake a large revision of his present production and exportation methods. The small saving, which might be made by using the St. Lawrence route for stock shipments would be altogether insufficient to initiate a large reorganization of the industry. Our analysis has, in fact, tended to exaggerate the importance of transportation in relation to other cost factors. When the additional severe limitations which the closed season and the seasonal distribution of production peaks are brought into the picture, there is added a factor almost conclusive in itself.

[17] Even the difference in seasons between the Northern and Southern Hemispheres works disadvantageously, for the spring and summer months there come at a time when either the St. Lawrence route would be closed or the domestic market here would be receiving the major part of the manufacturer's attention.

Traffic experts have joined in our judgment that the St. Lawrence waterway would not induce fundamental changes in the automobile industry.

i. *Tonnage estimate.* In view of the distance handicap of the all-water route from lake points to regions of the world other than northern Europe and the improbability of frequent liner service being available to the ports of the Orient, to those of South America, and even to those of southern Europe, we shall base our estimate of potential automobile traffic on the export movement to northern Europe. Starting then with our 1927 exports to northern Europe, including all of France, we find these amounted to about 55,000 passenger cars and 20,000 trucks, or 75,000 cars in all. Reducing this figure by one-half for movements during the season when shipping service via the St. Lawrence would not be available, leaves 27,500 passenger cars and 10,000 trucks. The higher priced cars and cars produced at points not on the Lakes would generally use present routing methods. If we assume, however, that a third of our exports to northern Europe would as a regular thing make use of the St. Lawrence route, we should have, on the basis of a weight of four thousand pounds per passenger car and six thousand pounds per truck, approximately 28,500 tons of traffic. This figure we may triple to allow for a rapid growth in the next decade or so, giving 85,000 tons of traffic. More tonnage than this might actually move over the waterway to various other trade regions, but only on that "occasional" basis that does not entitle it to a place in our estimates. Of the 85,000 tons a considerable portion might represent shipments of the Ford Motor Company made in that Company's own boats.

American shipments of parts, unit assemblies and service appliances, including engines, to northern Europe in 1927 aggregated in the neighborhood of 125,000 tons. If we assume that one-half of these pass out during the closed season and, liberally, that as much as a half of the remainder would use the St. Lawrence route, we have some 31,250 tons of traffic. If we triple

this to allow for rapid growth we have an additional 95,000 tons of export automobile traffic for the St. Lawrence route.

Canada's exports of cars, trucks, and parts have ranged in value in recent years from 8 to 15 per cent of American exports. Detailed statistics are not readily available, but the United Kingdom and the various colonies are her important markets. Reasoning as we may by analogy to the situation south of the border, we may liberally calculate that perhaps as much as 30,000 tons of Canadian export traffic would use the St. Lawrence on a regular basis.

j. *Reaching coast markets via the waterway.* Some anticipate that, with the St. Lawrence route available, deliveries from Middle West factories to Atlantic, Gulf, and Pacific Coast points would be made by boat. We can test this supposition by noting the characteristics of the route and the likelihood that the necessary coastwise service would be established.

At the present time some machines and parts reach South Atlantic points via New York and boat, and Mr. Ford has experimented with sending boatloads of supplies direct to his branches at Jacksonville, New Orleans, and Houston. All-rail movements direct from factory are, however, used almost exclusively in reaching coast points at the present time. The answer is found in the need for quick deliveries. From Detroit to the Pacific coast all-rail takes about 12 days, via New York and the Panama Canal 28 days; and, if the all-water route were available, something like 38 days would be required. During the active selling season such slow deliveries would absolutely prohibit use of the St. Lawrence route. Prompt and regular service is, if anything, more important in the case of domestic shipments than in the case of exports, partly for the reason that the shorter the haul the more exacting the requirement. To be sure, dealers do stock up against the spring and summer demand, but stocks are accumulated during the winter months, when use of the St. Lawrence route would be out of the question. On a service basis none of our coasts could be reached by boat in competition with the all-rail routes.

But, it may be suggested, would not the savings be sufficient to induce dealers to order ahead so that the time factor would not be important? For automobile shipments generally the answer is, no. The present rate on passenger cars from factory door at Detroit to Pacific terminal is $4.65 pèr hundred pounds. A water carrier, provided it had sufficient general cargo to warrant establishment of the service, might conceivably cut into this rate very considerably. And yet it is doubtful whether this saving would draw traffic to the route, particularly under the present conditions, when cars can go by rail unboxed. Let us make the assumption, however, that vessels in the "intercoastal" trade would equip themselves to handle unboxed automobiles. The question then becomes one of balancing a possible small saving in transportation charges against poorer service.

Some light on the likely frequency of service can be obtained by noting present sailings from the East coast to the West. A number of the lines give only bi-weekly service, although some give service as frequent as every four or five days from New York, Boston, and Philadelphia, with less frequent, sometimes monthly, sailings from Baltimore, Norfolk, and Charleston. The boats of one large company clear Boston on, let us say, the ninth, Philadelphia on the fifteenth, and New York on the eighteenth. Those of another line clear Philadelphia on the sixteenth, New York on the twenty-sixth, Baltimore on the thirtieth, Newport News and Norfolk on the first and second, respectively. Seventeen days elapse before final sailing is made. As a rule, sailing dates of the various companies are bunched rather than scattered and of course shipping contracts would limit the shipper to the boats of the contracting vessel line. Without attempting further detail, we may put it down as fairly certain that a tri-weekly or monthly packet service is all that would be likely to develop between the Great Lakes and the Gulf and Pacific Coast regions, with perhaps a little more frequent service to the Atlantic coast. Total delivery time would be very slow and there would be an average wait of about two weeks in getting shipments under way.

The conclusion follows, therefore, that, in view of the type of service required by automobile traffic, use of the route for shipments to the coasts would be limited in extent. That is, as a rule shipments would not be held back for a fortnight or more for a scheduled sailing, nor could most shipments stand the long delivery time. Such use as might be made would be limited to shipments originating in the important lake ports and to such other shipments as, during a dull period might be attracted by the saving in rates. Bearing in mind the effect of the closed season, particularly on stock shipments, we might set down some 75,000 tons of traffic in automobiles (mostly low-priced) and in parts, both for assembly and replacement. This is on the assumption that some cargo liner service between the Lakes and the coasts would develop. The bulk of this traffic would be with the Pacific Coast, where, if anywhere, a rate advantage would be found.

In addition, the Ford Motor Company might find it advantageous to use this route in carrying its products to the Pacific coast. At the present time this traffic is moved to Atlantic ports by train and then carried in Ford Company boats through the Panama Canal to Pacific coast points. The problem at issue is whether it would be profitable to transport Ford products all the way from Detroit to Pacific coast ports by water. It would depend upon whether, in view of the greater distance and time required to go by water, any net savings could be effected. The advantage of the St. Lawrence would obviously lie in the saving of the cost of transshipment from rail to water. No data are available on which to base a definite answer to this question. In order, however, to give the waterway the benefit of the doubt, we shall assume that as many as 40,000 tons of such traffic (equivalent roughly to 40,000 cars) would use it. To allow for a Canadian intercoastal trade between the Ford plant at Windsor and the West coast we shall assign a fourth of this traffic to Canada. Such boats would doubtless bring back some traffic from the Pacific coast, mainly lumber from the

Northwest. (In our lumber estimates we are allowing 20,000 tons for this back-haul traffic.)

Some indication of the correctness of our conclusion regarding the general shipper, which represents also the judgment of many experienced automobile traffic men, is found in the results of several experiments in using the less desirable routings for the savings which they were thought to offer. One of the biggest shippers tried to use certain of our internal waterways, but the savings of one dollar per hundred pounds was found not sufficient to compensate for the slow delivery time. Attempts have been made to use Atlantic ports other than New York—Charleston and Norfolk, for example—for automobile exports, but although some saving was possible (under the special conditions obtaining), this was not sufficient to warrant the continuation of the practice. Again, an important manufacturer in the East, in spite of the fact that a considerable saving on shipments of trucks to the Pacific Coast was obtainable by using the rail-and-water route via New York and the Panama Canal, was requested by the dealers at Los Angeles and San Francisco to ship wholly by rail in order to better the delivery time. A large truck manufacturer in a lake city reports it must have the best of service on its shipments. Heavy trucks, in fact, are even more of a special order business than are passenger vehicles. These examples all show that in judging automobile traffic great importance attaches to considerations other than freight charges, and, so far as can now be judged, this will doubtless continue to be the case.[19]

[19] Our conclusion here has been influenced by a study of the present movement of automobiles between the lake cities. Despite favoring circumstances, in 1927 only some 200,000 tons of such traffic were carried by boat between the important lake cities. A very large part of this traffic represents shipments of the Ford Motor Company in its lake boats. Chicago received in 1927, 35,000 tons, and shipped practically none; Detroit received 15,000 tons and shipped 166,000; Toledo received 782 tons and shipped 19,000; for Cleveland the figures were 80,000 and 20,000, and for Buffalo 51,000 and 9,000, respectively. And yet packet service on the Great Lakes is much better than any that is likely to be ob-

American imports of automobiles and Canada's imports from countries other than the United States are of negligible amount and would use only the best of transportation service.

2. *Other vehicles.* Here are included motorcycles, bicycles, carriages and wagons of all sorts, and certain miscellaneous vehicles.

a. *Motorcycles.* What has been said of automobiles applies also to motorcycles, except that the product is perhaps more standardized. Europe is a larger market than she is for our automobiles, taking nearly half of our exports in recent years. However, with total exports averaging less than 22,000 motorcycles in 1925-1927, orders must go in small lots and move rapidly. Nearly 90 per cent of our exports, other than those going to Canada, pass out through New York.

Including parts, except tires, our exports averaged about 7,000 tons in 1925-1927. Even allowing liberally for growth, there is relatively little traffic here, and when deduction is made for shipments from Eastern points of production, for shipments during the closed season, for shipments to points not readily reached via the St. Lawrence, and, generally, for those requiring expeditious movement, very little traffic is left. The fact that Europe is so important a market and that there is some production in Great Lakes cities, suggests that possibly some small use on other than an "occasional" basis could be made of the waterway. Perhaps 750 tons of such traffic would develop.

Canada has only a very small volume of exports and her imports are almost wholly from the United States.

Domestic trade in motorcycles would require all-rail service.

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tainable between the Middle West and coast points. By way of contrast, the railroads of the eastern district originated 5,300,000 tons of automobile traffic in 1927.

It is reported that in 1926 two large automobile manufacturers used rail-water lines in reaching an important export market. This was done in part to drive a better bargain with the standard rail lines.

Motor boats are too small an item and shipments are too irregular and require too high a grade of service to give promise of any traffic for the waterway.

b. *Bicycles.* Our exports of bicycles, which averaged 6,000 in number in 1925-1927, offer little opportunity for traffic for the waterway. Europe and Canada are very poor markets, Latin America and the Far East taking in these years, 95 per cent of our exports. Production is scattered, but the East, particularly Massachusetts, leads, with such Middle Western states as Ohio and Illinois also important. But when the location of our markets, the character of service required, the small size of the individual shipment, the closed season, etc., are all taken into account, the only use likely to develop would be a very small amount of "occasional" traffic.

Canada's exports also are small and her markets probably have much the same location as our own. Production is largely at Weston, Ontario, eight miles from Toronto. The situation relative to choice of routes is different in Canada from what it is in the United States. The St. Lawrence would be more of a factor than with us. But, even so, any use that might be made of the service likely to be available would be of small extent and in considerable part "occasional" in character.

c. *Carriages and wagons.* Exports of carriages are small and of decreasing importance. The greater part go to Canada and Mexico and other nearby countries. Movements to contiguous countries would be all-rail. No appreciable use of the waterway would be possible.

Wagons and drays are more important, our exports averaging over 6,000 in 1925-1927. Here again Canada and Mexico are our chief markets, together accounting for 70 per cent of the 1925-1927 exports. Europe takes practically none. Production is quite scattered and takes place chiefly at inland points. When account is taken of the large part of our exports that would move to contiguous countries all-rail, of shipments from points whence, on a rate basis, the St. Lawrence route would

hold out no attractions, of the small size of individual shipment, and the effect of the closed season, practically no traffic remains. We will assume, however, that large manufacturers of other agricultural appliances could include some wagons in their bulk shipments. On this basis principally, as much as 750 tons of this traffic might use the waterway. On a liberal estimate, an additional 250 tons of Canadian exports may be included.

Our exports of wheels, other than automobile and car, though quite extensive, go in very large part to Canada. Latin America takes most of the rest. Use of the waterway would be very limited at best. This is, however, a relatively low grade of traffic and some use might be made of the inferior service available on the St. Lawrence. The same may be said of Canada, whose options as to routings are more limited than our own. Perhaps 500 tons of traffic, divided equally between the two countries, can be set down under this head.

d. *Hand-propelled vehicles.* Of wheelbarrows we exported an average of over 107,000 in 1925-1927. Latin America, the Far East, and Africa are our only important markets. Production is predominantly at points not adjacent to the Great Lakes-St. Lawrence system. There is, in fact, little to favor use of the St. Lawrence for this traffic. However, we will set down 500 tons of exports under this head and allow a third of that amount, or, say, 150 tons, for Canadian exports.

We import no wheelbarrows and Canada's imports are small and from the United States.

Of push carts and hand trucks we exported an average of 62,500 in 1925-1927. Canada and Cuba are large customers, and Latin America and the Far East are also important. At best there is considerably less than a thousand tons of traffic here, and by the time direct rail movements to Canada, Cuba, and other contiguous countries are taken out and the other necessary deductions made, little traffic is left for further consideration. The same may be said of Canada.

There remains a miscellaneous group of vehicles and parts of vehicles, of which baby carriages and go-carts are an important part. Our exports range from 10,000 to 12,000 tons a year. Europe is of no importance as a market. Canada is a very good market and so is Latin America. Without attempting refinement, which is difficult anyway because of the miscellaneous character of these products, we will assume that, allowing for an increase in years to come, 2,500 tons of this traffic could use the waterway. This figure is made distinctly liberal to compensate for any underestimates that may have occurred elsewhere in our analysis of vehicles other than automobiles.

Correspondingly, 750 tons might be set down for Canada under this miscellaneous heading.

Imports of vehicles are small and come largely from Canada. For the remainder, which come from Europe, a high grade of transportation service would likely be needed. Canada's imports, other than from the United States, are of small extent.

" Domestic " movements in both countries would be likely to continue all-rail.

e. *Railway cars.* Our foreign sales of electric railway passenger cars have not been large (only 72 on the average in 1925-1927) and of these many have gone to our neighbors on the north and south, moving directly through to destination by rail (by car ferry to Cuba). Sales are by special order and deliveries must be made by specified dates. Production occurs chiefly in New York state, Pennsylvania, and Ohio (Cleveland and Cincinnati). Clearly, any use that might be made of the St. Lawrence would be of the slightest extent and of a most fortuitous character.

Of steam railway passenger cars we exported an average of 216 in 1925-1927, with Latin America our best market, neighboring countries the next best, and a few cars going to the Far East. Production is at such points as Michigan City, Indiana; Pullman, Illinois; Wilmington, Delaware; etc. What is said of electric railway cars applies equally here.

Our exports of freight cars are more on a quantity basis, averaging some 4,500 in 1925-1927. Latin America is again our best market. Exports to neighboring countries would of course be direct by rail in a large percentage of the cases. New York accounts for most of the remaining exports, which go to non-contiguous Latin American countries and to the Far East. Production of freight cars has become somewhat diffused in recent years, though relatively few of the companies engage in an export business. In evaluating the traffic possibilities in this case it must be borne in mind that sales are made only by special contract, deliveries following in a period of a few months. In bidding for such business transportation charges are of course considered, but it would be a rare case when a company could definitely figure its transportation costs on the basis of the service likely to be available from the Lakes. Once the order is completed it is moved out as quickly as possible. It would be only fortuitously that there might be a vessel sailing from the Lakes with proper destination at a time when an order was ready for movement. A majority of the companies engaging in this export business have plants in the East and some of them have no other plants. It is conceivable, of course, that a company with plants both in the East and the Middle West would use the latter at times for exports, but it seems likely that most of the construction on export contracts would take place in the Eastern plants. There may also be some question whether the facilities at the lake ports would be adequate to handle this type of traffic.

Under the circumstances, it would be impossible to set down any tonnage estimate that would have any significance. In this instance there is a combination of too many unknowns to make reliable prediction feasible. In thus leaving the subject we do not, as a matter of fact, omit an item of any considerable size. Our 1925-1927 exports, 4,500 cars, at an average weight of 22 tons per car (derived from a representative sample), yielded only 100,000 tons of traffic in the aggregate, of which a considerable part would move by rail direct to destination,

another part would move during the closed season, and another very large part would be produced at points from which use of the St. Lawrence would be out of the question. It is doubtful whether with more than 5,000 tons of such traffic delivery date would coincide with date of sailing of a boat having proper destination and the necessary accommodations.

We have no imports under any of the above heads, and apparently the same is true of Canada. The latter does, however, export some cars, a few to the United States (which we need not consider) and, in recent years, a fluctuating but generally not large amount to other countries. Production is, however. mostly in eastern Canada, the only exception being a plant at Hamilton, Ontario. This plant would operate under the same difficulties that occur in the case of corresponding American plants. No significant traffic figure can be set down under this head.

No "intercoastal" business on traffic that can move most cheaply on its own wheels would, of course, be possible.

A final class of freight car equipment is mine cars, of which we exported an average of 1,625 in 1925-1927. These are smaller cars than those considered above and to some extent are a "stock" proposition. About one-third have gone in recent years to contiguous countries and the remainder to other Latin American countries and to the Far East. Movements through the Gulf are rather large, but New York accounts for about two-thirds of the total. Details as to points of origin of these exports have not been readily obtainable. A very considerable part of the production is in the East, however, and most of that in the Middle West appears to take place at points which would require a rail movement to lake port. Under the circumstances, the possibility of using the St. Lawrence is not great, particularly as our markets are almost wholly in Latin America and the Far East, regions which least favor use of the St. Lawrence route. While it is possible that a little business of this character would find its way to the infrequent boat available for shipments to such points, it is doubtful

whether the industry could adapt its shipments so as to make substantial reliance on the waterway service. In other words, what little business might offer would be of an almost wholly "occasional" character and, therefore, is not included in our estimates. At most, such traffic could not exceed 500 tons.

Canadian movements have been considered in connection with other freight cars. The United States imports no mine cars.

No "intercoastal" business seems likely, as becomes evident when notice is taken of the location of our mining areas. They lie in the interior almost exclusively, and can best be reached by direct all-rail shipments.

Lastly, there are parts of cars (except axles and wheels, considered elsewhere) remaining for analysis. Of these we exported some 25,000 tons in recent years, about one-third going to contiguous countries and the remainder to other Latin American countries and the Far East. Under this head are included coupling and braking devices, guards, etc. Except for a part of the movements to contiguous countries, New York is the only important point of exportation. The great number of points of origin of this varied class of traffic renders accurate calculation of traffic possibilities out of the question. The extensive dependence on New York suggests, however, the need for a high class of transportation service; and a general acquaintance with the industry identifies it with certain railroad and steel centers, such as Chicago, Pittsburgh, and St. Louis, with a large part of the production taking place in the East or at points back from the Lakes from which there could be no advantage in using the St. Lawrence route.

If we assume total exports of 40,000 tons by 1940, deduct a third for direct rail movements to contiguous countries, deduct about one-half of the remainder to represent shipments during the closed season, assume that a third of the remainder would originate at points whence there would be some possibility of using the St. Lawrence for movements to the markets indicated, and that a half of this, or approximately 2,500 tons, might

actually use the route, we shall be distinctly liberal throughout. The figure thus obtained clearly represents the maximum use that could be made of the waterway. Some of even this small amount of traffic might properly be termed "occasional," but this is not done because there is more of an opportunity in this branch of the industry to make some adjustments to the service available.

VII. Miscellaneous Machines and Appliances

1. *Cash registers.* In 1925-1927 we exported an average of 30,000 cash registers to a very scattered list of countries. Some 530 tons of parts were also exported. Production takes place very largely at points from which there would be little or no inducement to route this traffic via a lake port. The saving, if any, would be too slight to attract this type of traffic, with its need for frequent, expeditious, and dependable service.

Canada's imports are wholly from the United States, and apparently she does no exporting.

2. *Typewriters.* There is little likelihood that the St. Lawrence waterway would be used in the exporting of typewriters. Production is largely confined to the Eastern states and a high grade of service is required. One company whose plant is about 50 miles west of Chicago might make "stock" shipments to its branches and agencies abroad, but such use would be too slight to be stated in tonnage terms.

The only Canadian production is in the hands of a subsidiary of an American typewriter company and exports are extremely small. Canada's imports come almost wholly from the United States.

3. *Adding and calculating machines.* We exported in 1925-1927 an average of nearly 50,000 of these machines, largely to Europe, Canada, Cuba, Mexico, etc. Production is predominantly in the lake states, and the port of export in four-fifths or more of the cases is New York. Such machines constitute a high grade of traffic, moving in export with considerable

regularity, whose routing is influenced to only a minor extent by small savings in freight costs. In other words, if any use should be made of the St. Lawrence route it would be only for those shipments which were immediately ready for dispatch at the time a vessel became available, and, owing to the longer delivery time to final destination, even such shipments (except perhaps to northern Europe) might find no advantage in using the St. Lawrence route. We conclude, therefore, that such use, if any, as might be made of the route in reaching destinations other than ports of northern Europe would be " occasional " and so to be excluded from our final estimate. Sales to England, France, Germany, and perhaps a few other places are of sufficient size to make possible " stock " shipments to agencies in those countries. These can go somewhat more deliberately than other shipments and so could use an infrequent vessel service. An allowance of 500 tons of such shipments via the waterway would be distinctly liberal.

Canada's exports are small, and any use that might be made of the waterway would be " occasional." Her imports are almost wholly from the United States.

4. *Addressing and duplicating machinery.* Our exports of these products averaged 5,500 in 1925-1927 and were rather widely distributed. Europe generally takes about 40 per cent, and is the only region to which shipments might go via the St. Lawrence. Production is largely in the East, though one large concern is found at Cleveland. This is so distinctly a high grade of traffic and shipments are in such small lots that it seems out of place to enter into a serious discussion of what it may offer for the St. Lawrence. Shipments to a few European countries of " stock " supplies, if this became the business practice, might be made, but so small would even such shipments be and so problematical the advantage of carrying considerable stocks abroad in preference to ordering smaller lots from the factory to keep a current supply on hand, that no use of the waterway, except perhaps for some " occasional," traffic would be made.

5. *Gas and water meters.* There is unlikely to be any use of the St. Lawrence waterway for the movement of these products. Production is predominantly in the Eastern states and our markets, aside from Canada, are very largely to the south of us and in the Far East. Orders are irregular in character and are shipped in lots rather than serially. Frequent and fast service is required on most shipments. Intermittently, small shipments might be made from Chicago or Cleveland, for example, but the amounts would be too small to reduce to a tonnage figure.

6. *Other machinery and parts of.* Here again we have to deal with a miscellaneous group of exports, rather large in extent (some 43,000 tons in 1925-1927) and going to a wide scatter of countries. Europe takes about a fifth, Canada a third, and the remainder go to Latin America and the Far East. Definite analysis is impossible. The value per pound is high and indicates the need for a good grade of transportation service. Applying the reasoning used in connection with other machinery, but allowing all that is possible in order to compensate for under-estimates that may have occurred in connection with other articles, as much as 5,000 tons of export traffic may be set down under this head.

Our imports are considerably smaller and come principally from northern Europe. On a most liberal basis and again allowing for under-estimates elsewhere, 1,000 tons of traffic might be found under this head.

Without attempting any refinement of analysis, we will set down, as corresponding figures for Canada, 500 tons of miscellaneous exports and 500 tons of miscellaneous imports of machinery.

APPENDIX G

ORES AND METALS

I. Copper

1. *Crude and refined copper.* We must devote some little space to copper, since it moves in foreign trade in sizeable quantities and the welfare of the domestic industry is to a considerable extent dependent upon exporting our surplus production. In its marketing, copper may also be looked upon as representative of many of the higher value metals.

Though crude copper is mined in a considerable number of states, the production of refined copper ready for the trade is confined to four regions: (1) the Eastern seaboard, principally in the vicinity of New York City and in Baltimore; (2) the Michigan copper district; (3) Great Falls, Montana; and (4) Takoma, Washington.[1] Refined copper is sold to the trade, usually in carload lots, in the form principally of wire bars, but also as ingots, slabs and cakes, cathodes, etc. Sales are usually made for one to three months' delivery. Fabricators of copper products are found almost exclusively east of the Mississippi River. New York is the one great American copper market. Eastern refined copper dominates the Eastern market but meets copper shipped from the Michigan refineries in the Middle West (Buffalo to St. Louis); the Western market is amply supplied from the Western refineries.

Copper exports are made very largely from New York and Baltimore, though a considerable amount moves out via Washington ports, particularly to the Orient, and that going to Canada moves largely through Buffalo—St. Lawrence and Michigan gateways. Exports move with considerable regu-

[1] For a discussion of the copper industry see F. E. Richter's chapter in H. T. Warshow, *Representative Industries in the United States*, 1928, and E. H. Robie's chapter in Spurr and Wormser, *The Marketing of Metals and Minerals*, 1925.

larity the year round. For the most part, high grade transportation service is required. Such, in brief, are the business facts with which we must reckon in determining the amount of copper likely to go over the St. Lawrence route.

Some have predicted a large movement not only of Michigan but also of Montana copper over the proposed St. Lawrence route.[2] It is our conclusion, however, that deepening the St. Lawrence would have no important effect upon the movement of copper. The relative decline of Michigan and Montana copper production in recent years and the rise of production in the Southwest has not been primarily due to high rail transportation charges. The newer sources of supply, Arizona and New Mexico, Cuba, Mexico, South America, and even Africa, all enjoy the advantages of low mining costs. Cheap ocean transportation has also played a part. The combined result has been to enable the Eastern refineries practically to determine prices in the large Eastern markets. These advantages would not be materially affected by the opening of the St. Lawrence. That Michigan copper has been able to enter the Eastern export markets at all is largely because of certain peculiar properties which make it particularly desirable for certain uses.

Careful examination of the situation makes it appear very unlikely that any appreciable amount of Michigan or Montana copper would reach the Eastern market via the roundabout St. Lawrence route.[3] In recent years the shipping charge on

[2] It has even been suggested that Arizona unrefined copper would move to a lake port and thence by water to the seaboard refineries. It is unnecessary to give this proposition serious consideration. The long rail haul to a lake port and roundabout water haul from there to the Atlantic refineries would be wholly unable to meet the competition of a movement via the Gulf.

[3] According to Gregg and Cricher, *Great Lakes-to-Ocean Waterways*, p. 120, of Michigan's average 1921-1924 exports of 7,465 tons, 4,734 passed out through her own gateways, 1,997 tons via New York, 603 tons via Baltimore and 117 tons via Philadelphia. Montana's exports totalled 1,435 tons, of which 1,190 passed out through Washington ports and 245 via New York.

copper down the lakes, mainly to Buffalo, has been in the neighborhood of $4.50 per ton. To carry this copper around to New York and that general vicinity via the St. Lawrence after Buffalo has been reached would require at least a doubling of this rate. There would still be the cost of cartage, and possibly a short rail haul from New York to destination, which would be rather a large item. In all, the margin of saving, if any, under the all-rail rate of $10.00 or the lake-and-rail rate of $8.80 from Houghton to a typical point such as Waterbury, would be so small that, when taken in connection with the greater time in transit and the interest on the money tied up, it would not appear likely that, except under special circumstances, any Michigan copper would find its way to the Eastern market over the St. Lawrence route. The factors are much the same in the case of Montana copper. Copper that once gets on the Lakes is likely to go no further than Buffalo, whence the New York district can be easily reached by rail. It is conceivable that a small amount of copper might, when conditions were favorable, find its way around if a packet service should develop.

Nor is there good reason for believing that the opening of the St. Lawrence would greatly stimulate exports. Eastern refineries have an advantage much greater than could be compensated for by a reduction in water rates. The most that can be said is that under exceptional conditions—with prices high, demand brisk, and supply from other sources lagging—some shipments of Michigan copper might be dispatched direct by water, provided this situation occurred during the open season of navigation. Such Montana copper as might be exported would find nearby Pacific gateways a more economical route than over a long rail haul to lake ports.

Weighing all of the essential factors—lower production costs elsewhere, the near and growing Middle West market, the increasing competition of foreign supplies in European markets, the use of aluminum and other copper substitutes, the closed

season of navigation and the advantages of using high grade service and regular routings the year round, the out-of-the-way position of Michigan copper shipping points for liner service, the declining use of lake transportation for copper,[4] and the westward pull on the Montana production, we conclude that not in excess of 3,000 tons of copper per annum would move over the St. Lawrence route. Of this 2,000 tons might be copper moving to the Eastern market and 1,000 tons copper moving directly in export. The figures given are liberal, in that in reaching them many important doubts, particularly as to vessel service and the future of our exports of Midwest copper, have been waived.

The industry is so organized that there would be little or no occasion or opportunity to use the St. Lawrence route for bringing in our water-borne imports. Imported ores go to our East and West coast refineries, while refined copper would continue to pass through the New York market. Nor would domestic refined copper be able to move by packet service into the Lakes in competition with the direct rail haul.[5]

Canada's foreign trade in copper is very largely with the United States. Her biggest production of copper is in British Columbia, from which point obviously no use could be made of the St. Lawrence route. Her second largest area of production is in the Sudbury district, Ontario. So far as exports to the United States are concerned, no use would be made of the St. Lawrence route. The largest company there has its refinery at Port Colborne. One of the companies in this area exports copper ore, matte, and regulus to Swansea, Wales, for refining.

[4] Evidenced by the fact that the practice of trying to crowd shipments over the lake route just before the close of navigation has been given up because it did not pay. In 1900, 131,000 tons of copper passed through the Sault Ste. Marie canals, in 1910, 148,000, in 1915, 156,000, but in 1927 only 67,000 tons.

[5] This situation differs from the "outbound" domestic movement in that the interior markets, in contrast to the interior production points, are scattered and at relatively shorter distances from the East coast.

In the years 1924-1928 these shipments averaged not over 7,000 tons. As in the case of nickel, in which a similar practice will be seen to obtain, it does not seem likely that an arrangement could be worked out as satisfactory as putting the commodity into Montreal by rail for shipment from there. To be liberal, however, we will set down 2,000 tons per annum as representing the total Canadian use of the St. Lawrence waterway. Of this little or none would represent imports, which, on a tonnage basis, come almost wholly from the United States.

2. *Manufactures of copper.* The principal item here is insulated wire and cable, of which we exported some 7,750 tons in 1924. Other exports of manufactures of copper aggregated 2,350 tons in that year. Our best markets are in Latin America; Europe and the Far East take relatively little. Deducting exports to Canada, 90 per cent of these pass out through New York, a fact which denotes extensive production in the Eastern states and the need for adaptable service and reliable and expeditious delivery. Of 52 factories engaged in the manufacture of copper wire, as reported in the Census of 1923, 41 are in the New England states, New York and Pennsylvania. Certain large producers having plants in both the East and the Middle West undoubtedly would use their seaboard plants almost exclusively for their export business. Other manufactures of copper constitute a miscellaneous group, signifying small size of individual shipments and the need for rapid and adaptable transportation service.

Canada's imports are very largely from the United States and her exports are of very slight extent.

We can foresee no appreciable amount of traffic for the St. Lawrence under this head.

II. Lead, Zinc, Brass, and Bronze

1. *Lead.* Our lead industry is pretty largely confined to the Middle and Far West, production taking place principally in Missouri, Idaho, Oklahoma and Utah. Points of consumption

are chiefly New York, Chicago, Philadelphia, and St. Louis, though there are numerous other consumption centers east of the Mississippi. Much Western lead reaches Eastern points on water by boat; to inland Eastern points Western lead is shipped all-rail largely via Chicago.

There is nothing in this situation which would permit use of the St. Lawrence route either for domestic or export shipments. Our exports consist largely of refined leads, produced principally from foreign ores, but also of some manufactures of lead, and move in the greatest number of cases out of New York, with Pacific and South Atlantic ports of secondary importance. There is little or no likelihood of these being diverted in any significant amount to the St. Lawrence route, in view of the necessary originating rail hauls, some of which would be quite lengthy, the greater variety and frequency of shipping service available at New York, and the continuing importance of present marketing practices and channels. Should extensive brokerage develop at some lake port, presumably Chicago, and regular, dependable liner service be available from there, it is possible that there might be enough of a saving to draw a little lead to the water route. But it is not likely that exporters would regard the savings this route might make possible sufficiently important, especially in view of the seasonal closing, to warrant any significant use of or dependence on the St. Lawrence route.

We import considerable lead ore and matte, mainly from Mexico, and lead bullion, almost exclusively from Mexico, as well as smaller amounts of refined lead in various forms, and scrap lead. The ore and matte come in principally via El Paso, Texas, the bullion at New York, with the Omaha customs district a factor of secondary importance, and the remaining items at New York and Philadelphia, with Omaha again of secondary importance. There would be no object in bringing the imports from Mexico and South America clear around into the Lakes. Nor would Canadian lead be brought in from the principal

region of production, British Columbia, by such a roundabout route. The remaining importations, from Europe, are of such minor extent as not to require attention. There is no likelihood that they would furnish more than the most irregular bits of traffic for the St. Lawrence.[6]

Canada's exports in recent years have gone in their entirety to the United States. Should an important trade with other countries develop, there still would be little occasion to use the St. Lawrence, since production is primarily in British Columbia and that in Ontario is at a point not far distant from Montreal, the natural shipping point. Her imports of lead and manufactures of lead are of minor extent as a rule and at best could furnish very little tonnage for the St. Lawrence.

2. *Zinc.* The situation with respect to zinc is much the same as that with respect to lead. The zinc ore is largely a product of the states of Oklahoma, Kansas, New Jersey, and Montana, the last, with British Columbia, furnishing electrolytic zinc. The greater part of the refining is done in the states of Oklahoma, Illinois and Pennsylvania. The great zinc market is East St. Louis. There is no possibility of advantageously moving domestic or Canadian zinc ores to refineries by the St. Lawrence route.

Our exports of the ores, concentrates and dross, which do not run very large, go mainly to Europe, especially England, and use Philadelphia and Baltimore as the principal points of embarkation, but with Gulf and Pacific ports also important. The use of the less important North Atlantic ports perhaps suggests that in this instance poorer service can be tolerated in return for a saving in rates. We might, therefore, set down a small amount—let us say 2,500 tons—of the ores as possibly using the St. Lawrence route if a fair amount of vessel service became available.

[6] Most of our imported ores and matte are re-exported, being brought in in bond and, after refining, shipped out again, principally to Europe.

Our imports of ores, almost wholly from Mexico, enter in nearly their entirety at Southern gateways. No use of the St. Lawrence would be feasible without a considerable relocation of refining plants and this is unlikely.

Turning next to refined zinc in the form of blocks, pigs, slabs, sheets, etc., it can be seen that there would be no occasion to use the St. Lawrence route in reaching any of our domestic marketing or consumption points. It might be thought that some of the electrolytic zinc produced in Montana and British Columbia would come to the head of the Lakes for shipment by water the rest of the way to coast points. It can be said with fairly complete assurance that little use would be made of such a time-consuming, roundabout route. Under exceptional circumstances and with a fairly frequent packet service available, some might move that way, but the bulk of the zinc would continue to move all-rail to Eastern points.[7]

Next, would any zinc move in export via the St. Lawrence? Our exports averaged around 70,000 tons in 1924-1927. For the principal item of export, spelter, the Gulf ports are mainly used, with New York and the Pacific ports of distinctly secondary importance. Of course this is the most natural routing in the case of zinc refined in Oklahoma and that vicinity, but in the case of zinc produced in the Illinois district use of this route indicates that, with the market centering there, there need not be, for this type of commodity, dependence on New York and the superior vessel service available there. Assuming, therefore, that vessel service of very moderate frequency would become available at Chicago, it is possible that some zinc would be found to use it in reaching points in northern Europe, where our principal markets are found. Assuming that such a development took place, it is possible also that some of the electrolytic zinc would have its journey to the coast broken at Chicago. Bearing in mind the competition of other

[7] A few hundred or a thousand tons of zinc now move via the "summer route," that is, Duluth to Buffalo, but the amount is not significant.

routes and other domestic producing centers, the seasonal closing of the route with its serious deterrent effects, the need oftentimes of immediate, fast, and definite delivery, we estimate that not more than 10,000 tons at the most would use the St. Lawrence route. This is in fact a liberal estimate, as it is based on the assumption of a large increase in our exports of zinc in these forms.

Our imports of refined zinc are of negligible extent.

The estimate above is believed to be liberal enough to cover any British Columbia zinc exported to Europe via either American or Canadian rail routes and the St. Lawrence. It would appear more reasonable to expect most of this zinc to go out via Pacific ports. The bulk of Canada's imports of zinc come from the United States and would not, except perhaps to a very minor extent in reaching a point like Montreal, require use of the St. Lawrence.

Our exports and imports of manufactures of zinc are of small extent. A large part of the exports goes to Canada and most of the rest to Latin America and the Far East. No use of the St. Lawrence waterway can be foreseen. Canada's foreign trade in these products is even smaller than that of the United States and conditions do not favor any use of the waterway.

3. *Brass and bronze and manufactures of brass and bronze.* These commodities are very closely related to copper, whose analysis just precedes. With the exception of scrap brass, there is not much tonnage in this group of products. Our exports of brass, pipes and tubes, valves and fittings, builders' hardware, wire, etc., averaged about 8,225 tons in 1925-1927. Our best markets are Canada, Latin America, and the Far East. The production of these articles is predominantly an Eastern industry, the one state, Connecticut, probably producing more than all the states adjacent to the Great Lakes put together. Excepting the movement into Canada, New York everywhere stands out as the one important point of export, though some use is made of New England, Gulf, and Pacific ports. In view of the location of our principal markets, the major points of

production, the need for a high class of frequent and dependable service, the small size of individual shipments, etc., we regard it as wholly unlikely that any recognizable amount of this traffic would seek the St. Lawrence route. A little " occasional " traffic might develop.

Much the same is true of our imports of manufactures of brass and bronze, which are of small extent (considerably less than a thousand tons). Small amounts of these might, conceivably, be brought in from Europe via the St. Lawrence.

We exported in 1925-1927 an average of nearly 40,000 tons of scrap brass and brass ingots, mainly the former, and imported about 4,500 tons, mostly scrap. The interchange is largely with Europe and Canada, and New York, Philadelphia, and Maryland take care of most of the business (except that with Canada). In view of the location of the brass industry in this country it would seem very doubtful whether any significant use would be made of the St. Lawrence route for the movement of scrap brass. The indications are that the North Atlantic ports would continue of most importance, for the market is there.

Canada's foreign trade in this group of products is not large and is mostly with the United States.

To be liberal, however, we will set down 1,500 tons as representing the amount of brass and bronze in their various forms which might use the St. Lawrence route. The greatest part of this would be scrap brass and about one-third would represent United States exports and two-thirds United States imports.

III. Nickel, Cobalt, Chrome, and Tin

1. *Nickel.* The world's greatest nickel producing area is at Sudbury, Ontario, a short distance north of Georgian Bay, from which region the United States gets nearly all of its supply. The total Canadian production normally does not exceed 35,000 tons per annum; the peak production, in 1917, was only 46,000 tons.

Our imports come in the form of ore and matte or as pigs, ingots, etc., principally the latter. Nickel is used in making alloy steels, in electro-plating, and in making alloys other than steel. The American demand is therefore largely in the steel districts, in the automobile district, and in the electro-plating and silver industries, largely along the Eastern coast. In view of the location of the producing and consuming areas and the high value of nickel, making transportation costs a relatively minor item, we can foresee no use whatever of the St. Lawrence route for bringing nickel into the United States.

Some nickel is carried from Canada to Wales for refining, part of the finished metal being brought back. In 1925-1927 the aggregate Canadian exports of nickel ore and matte have averaged nearly 20,000 tons. It is conceivable that some of this traffic might use the waterway, although it does not appear likely, since a rail haul from the mine area west nearly 200 miles to Sault Ste. Marie or south and around to a Georgian Bay point, from 120 to 180 miles, would be about as costly and certainly less convenient than shipping directly east by rail to make connections at Montreal. We do not, therefore, put down any figure against this item. For similar reasons and the location of her markets, it is unlikely that Canadian refined nickel could use the waterway.

Some nickel is being obtained from mines in New Caledonia, which lies off the east coast of Australia. Even should much nickel be obtained from this far-off place there would be no occasion for use of the St. Lawrence. The location of refineries and marketing agencies along the Eastern Coast, as well as compelling shipping considerations, would necessitate its being brought in at New York and adjacent ports.

Our imports and exports of refined nickel and manufactures of nickel are of such slight extent that they would provide no traffic for the waterway. The same may be said of Canada's imports, which not only are of small extent but come very largely from the United States.

2. *Cobalt.* Our imports of cobalt ore and metal and of cobalt oxide are of small extent. Their movement would be governed by the same considerations as apply to nickel. No use of the St. Lawrence route is indicated.

3. *Chrome ore or chromite.* Imports of this commodity have averaged 196,000 long tons in 1925-1927. They originate mainly in Africa and Oceania, but also in British India, Greece, and Canada. Philadelphia and Baltimore are the principal ports of entry, New York being of secondary importance. Everything points to the continuation of imports about as at present. The points of origin do not permit of direct vessel service into the Lakes, and the points of use also do not favor a roundabout haul via the St. Lawrence.

Our imports of ferrochromium, chromium metal, and chromium vanadium are of slight extent and pass almost wholly through New York, as they may be expected to continue to do.

Apparently no exports are made from the United States. Canada's exports of chrome ore have all been sent to the United States and would furnish no traffic for the St. Lawrence.

4. *Tin.* Our imports of tin amounted to 84,000 tons a year in 1925-1927. This commodity comes entirely from the Far East, though in some instances indirectly through England and the Netherlands. New York is the great American tin market, and practically all of our tin imports come through the port of New York. The high value of the product renders cost of transportation a matter of secondary importance. As is indicated in Appendix I, Section VII, no regular shipping services between the Far East and the Great Lakes may be expected to develop. It may also be noted that the industries which work up tin are in the main not located at points on or adjacent to the Lakes. It is, therefore, a practical certainty that the great bulk of our tin will continue to enter this country through the New York market. Imports of tin manufactured articles are of no importance. Canada's imports of tin and tin products are not large from a tonnage standpoint, and come to a great extent from the United States. The major part of the Canadian

industry is located in Quebec, New Brunswick, and other eastern regions. The amount worked up in cities like Toronto and Hamilton is negligible.

United States exports of tin are negligible in quantity. Our more extensive exports of tin plate, terneplate, and taggers have been considered in connection with the iron and steel group. Our exports of manufactured tin, including tin cans, amount to 7,000 or 8,000 tons a year, more than one-half of which goes to Canada and would hence be unlikely to use the waterway. Our largest markets outside of Canada are Latin America and the Far East, with a very wide scatter in both instances. The production of these goods is broadly distributed as to location, the largest single producer of tin receptacles having factories in the East, South, and West, and at several lake and interior locations in the Middle West, indicating a plan for short hauls on the finished products. Only a small fraction of our tinware is produced close to the Great Lakes. In view of the location of the industry and of our markets, the fairly high grade of transportation service required and the small size of the individual shipment, it is difficult to conceive that other than a very "occasional" traffic in tin would develop. Canadian exports of tinware are not extensive.

IV. Bauxite, Aluminum, and Antimony

1. *Bauxite.* Bauxite is used principally in the manufacture of aluminum, chemicals, abrasives, and refractories. It is produced in the United States to the extent of about half a million tons per annum, principally in Arkansas. Small amounts come from Alabama, Georgia, Tennessee, and a few other states. The domestic market for bauxite is largely in East St. Louis and Joliet, Illinois; Cincinnati and Columbus, Ohio; Philadelphia and Pittsburgh, Pennsylvania; Niagara Falls, New York; New York City, and Boston and vicinity.[8] Obviously, the

[8] Spurr and Wormser, *The Marketing of Metals and Minerals*, 1925, p. 250.

St. Lawrence could not be used in shipping domestic bauxite to any of these points. The largest movement is to the big alumina works of the Aluminum Company of America at East St. Louis, Illinois, whence the purified material is sent to its reduction works at Niagara Falls and Massena Falls, New York (down the St. Lawrence toward Montreal) and at Shawinigan Falls, Quebec, a point beyond Montreal on a tributary of the St. Lawrence River. The large power requirements of the industry have dictated the location of the reduction works. There are also smelting plants of this and other companies at New Kensington, near Pittsburgh, in Tennessee and North Carolina, and at Edgewater, New Jersey.

In view of these locations, it is evident that only the reduction plants at Massena and Shawinigan Falls could possibly use the St. Lawrence route for domestic shipments of alumina. That such use would not be likely is perhaps evidenced by the fact that no use is made of our present water transportation facilities down the St. Lawrence. Regularity, dependability, and speed are considerations in the routing of this traffic, and an all-year routing appears to be desired. The transfer cost at lake port would also be a deterring factor.

The only other movement is that of exports, practically all of which, aside from those to Canada, go to Norway. These now use and would continue to use Gulf ports exclusively.

Imports of crude bauxite are mainly from British and Dutch Guiana, with minor amounts from France and one or two other European countries. These enter principally at the Gulf for shipment largely by the Barge Line, to East St. Louis; secondary use is made of Philadelphia, and minor use of New York and the New England ports. No entries are shown at Montreal. Assuming no far-reaching change in the location of the bauxite refining industry, there evidently would be no occasion for use of the St. Lawrence for imports of crude bauxite.

2. *Aluminum.* Aluminum metal is sold in the form of ingots, plates, sheets, wire, tubes, castings, in various alloys, etc. The

locations of the various reduction works have already been indicated. Rolling mills, wire mills, and fabricating plants are found in conjunction therewith, giving us, then, the most important shipping points. So far as can be judged from the high value of the commodity, methods of marketing, and points of utilization of aluminum (as in the automobile district, in the manufacture of cooking utensils, wire, etc.), we regard it as wholly unlikely that any significant use could or would be made of the St. Lawrence, either for domestic shipments or for those to or from Canada. Should a packet service develop between Canadian river and American lake ports, some small amounts might find their way in or out by water, but only on an " occasional " basis.

Our exports to other countries have amounted to scarcely 5,000 tons in recent years and New York is used almost exclusively. Apparently no significant use would be made of the St. Lawrence for either American or Canadian exports.

We imported in the years 1925-1927 (from countries other than Canada) an average of 20,000 tons of aluminum in various forms, mostly from Norway and other European countries. New York is used almost exclusively as the port of entry. It is fairly certain that New York would continue to draw this business, having the facilities for handling it to best advantage. We shall, however, set down 2,500 tons of traffic here.

Our exports of manufactures of aluminum are not extensive and a third go to Canada, with most of the rest going to Latin America and the Far East. While there is a considerable production of aluminum ware and related products in a state like Wisconsin, no significant use of the St. Lawrence can be foreseen. With but few exceptions, a rail haul to lake port would be necesary, and such a haul, in view of the character of the product, would nullify any advantage there might be in using the St. Lawrence route. The service requirements of the industry also could not be met.

Canada's imports from and exports to the United States have already been considered. The location of the industry in Quebec

of course makes use of the St. Lawrence for Canadian exports (small at best) to other countries impossible, and her imports from countries other than the United States are of very limited extent.

3. *Antimony.* Our imports of antimony ore are of small extent. Those originating in Mexico usually pass through San Antonio, Texas, and practically all the remainder through New York. In view of the South American or Mexican origin of most of our imports of the ore and for other reasons, no use of the St. Lawrence is indicated.

Our imports of antimony metal in all forms, at the present time average about 12,000 tons per annum. China is the principal point of origin, with a fair amount coming to us from Europe. It is very unlikely that direct importation into the lake states would be undertaken. Should any so move, it would be in extremely small amounts. The same may be said of Canada.

V. Manganese, Ferromanganese, and Other Ferro-Alloys

1. *Manganese.* Manganese ore is used principally for the manufacture of ferromanganese. To a less extent it is used for the manufacture of dry batteries, brick and glass. Imports—amounting to some 622,000 tons in 1927—come from Russia, Turkey, India, Brazil, South Africa, and Cuba. Domestic supplies are of poorer quality and are more costly to work than the foreign supplies.

The manufacture of ferromanganese is limited to the following locations: Youngstown, Pittsburgh, eastern Pennsylvania, Reusens, Virginia, and the Alabama steel district. Imported ore is not used in the Gary steel district at the present time.

Imports of manganese ore are handled as parts of mixed cargoes of all classes of goods. In our analysis of trade with the Far East, we show that conditions in general do not favor the development of a waterborne trade between lake ports and Oriental ports. Likewise our analyses of commodities

originating in the other trade regions from which we obtain this ore lead us to the conclusion that local conditions in each case do not favor the development of direct steamship services into the Lakes. Taking these facts into account and the further fact that rail hauls would be necessary to connect Pittsburgh and Youngstown with Lake Erie ports, we do not believe that United States imports of manganese ore would use the St. Lawrence route. To take care of Canadian imports of manganese ore we allow 15,000 tons as potential traffic for a deep waterway.

2. *Ferromanganese and other ferro-alloys.* Ferromanganese is an alloy of manganese and iron which enters in varying proportions into the manufacture of steel. Our imports are mainly from England and northern Europe and amounted, in terms of manganese content, to an average of 55,000 short tons in 1924-1927. The use of ports of entry adjacent to the steel centers is noticeable, Baltimore and Mobile or New Orleans accounting for three-fourths of the present entries. As in the case of manganese ore, it seems likely that some direct importations into the lake steel districts could be made, though in the case of the large steel companies with plants in various sections there would be a tendency to centralize imports as much as possible, distributing from port of entry to the different mills according to their needs. An economy is effected through using one supply to meet the varying demands of the individual plants. For such companies there also could be only a relatively small saving in direct transportation charges by using the all-water route to interior mills. Mills which could be reached only by a back haul from lake port, such as those at Youngstown and in central and southern Ohio, could best be served from an Atlantic port like Baltimore. Deducting for shipments that would go to other ports of entry and for such as would come in during the closed season, and taking into account the tendency for our imports under this head to decline, an allowance of 7,500 tons per annum would be liberal. Of

this much the greater part would be brought in for use in the Chicago-Gary steel district.

Our exports of ferromanganese and spiegeleisen averaged 3,100 tons in the years 1924-1927. In some years most have gone to Europe, while in others Canada and Mexico have taken the bulk of the exports. Philadelphia stands out as the port of export. It seems reasonable to expect that the great bulk of our exports will originate at Eastern points. Some may, however, come from points further in the interior. An allowance of 500 tons of traffic for the waterway seems ample.

No movements of these commodities between the Great Lakes and our coasts can be foreseen.

Canadian import and export statistics do not reveal what movement there is of ferromanganese across its borders. We obtain small amounts from and send small amounts to Canada, but use of the St. Lawrence would be either out of the question or of very limited extent.

3. *Ferrosilicon.* Our imports here averaged about 11,000 tons in the years 1923-1927, with Canada supplying 80 to 90 per cent. Imports from Canada would be likely to be all-rail. They flow down through Buffalo and west and south through Michigan and Ohio gateways. Our exports in turn are small and go largely to Canada. Canada's exports go practically in their entirety to the United States. Her imports, if any, from countries other than the United States are extremely small.

4. *Other ores of ferro-alloying metals.* The makeup of this group of ores varies from year to year. In 1924 and 1925 our imports averaged 5,000 tons, but in 1926 and 1927 they were wholly negligible. Latin America (particularly Peru), Canada, England, and northern Europe are our sources of supply. Much comes in via New Orleans and is likely to continue to do so. Some of the imports from Europe might find their way around into the Lakes, though the variety of items and the many points of shipment tell against such movements being extensive. Our best judgment is that 1,000 tons per

annum of traffic for the St. Lawrence waterway would be reasonable.

From the information at hand it is difficult to determine what use Canada could make of the waterway. Apparently, her exports and imports under this head are very small, in which event any use that might be made of the waterway would be of slight extent. The location of the Canadian steel industry and the possibility of obtaining supplies from the United States, in some cases re-exports, also tell against any important use of the waterway.

5. *Other ferro-alloys.* The principal item here is tungsten and alloys of tungsten, with a number of other alloys showing up in our exports. At best the amounts are extremely small, the traffic is of a very high grade requiring expeditious movement, and the market for our exports is to a large extent in nearby Canada. For these reasons, it is unlikely that any use, except perhaps a little on an "occasional" basis, would be made of the waterway. The same may be said of Canada.

VI. Miscellaneous Metals

This is a varied group, consisting of babbitt metals, other metals and alloys, and type and other manufactures of metals and metal compositions. Total exports were about 6,500 tons in recent years. Canada took about a third of the total. This traffic characteristically moves in small lots and generally requires expeditious and dependable transportation service. In view of this fact and of the great variety of items, it is impossible to predict that any traffic under this head, except perhaps a little on an "occasional" basis, would move over the St. Lawrence waterway.

Imports of metals, alloys, etc., not elsewhere treated, amounted to nearly 13,000 tons in 1924 and to 19,000 tons in 1925. Canada is, however, the chief source of supply, accounting for 90 per cent of the 1924 and 60 per cent of the 1925

imports. For reasons often stated in other connections, movements of this class of traffic from Canada are unlikely to use the St. Lawrence waterway. Direct movements to points of use, often over very short distances and not infrequently in a southern rather than a lateral direction, are indicated.

To take account, however, of receipts from Europe of this group of commodities and of miscellaneous manufactures of metals, obtained mostly in Europe, we will set down, purely as an estimate, 2,000 tons of traffic for the waterway. An estimate of 500 tons of import traffic over the St. Lawrence may be set down for Canada.

These estimates are liberal enough to compensate for any omissions that may have been made in estimating other movements in the general group of metals other than iron and steel.

APPENDIX H

NON-METALLIC MINERALS

I. Coal and Coke

Coal is a low value, bulky commodity adapted to transportation by water. All possible movements of coal over the St. Lawrence route must, therefore, be analyzed with particular care.

It has been argued by some that, with the St. Lawrence open to ocean-going vessels, Pennsylvania, Ohio, West Virginia, and even Michigan coal could be exported to European and other foreign markets. Only a moment's consideration is required to see the impossibility of such a movement taking place. In the first place, " only our best Eastern coals are suitable for the export trade."[1] In the second place, European coal supplies, particularly the British, are so near at hand and are so badly in need of markets that it is unbelievable that our interior coal could meet such competition in the European markets.[2] The fact, already noted, that the balance of traffic over the St. Lawrence to European points would be predominantly outbound tells further against such an export movement. Any American exports of bituminous coal to European markets are therefore almost certain to continue to move out through the Virginia and other Atlantic ports.

In recent years we have sent considerable bituminous coal to the countries to the south of us. Obviously, the St. Lawrence is at even a greater disadvantage here than in the case of trade with Europe. If large quantities of commodities were

[1] Statement of F. R. Wadleigh, editor of *Coal*.

[2] These statements are made notwithstanding the fact that some Illinois coal was exported in the summer of 1926, when the British coal strike produced a wholly exceptional situation.

to move into the lake states from these countries coal might be used as return cargo, but examination of our imports from South and Central America and the West Indies shows that no important movement over the St. Lawrence route would be likely to take place.[3] It is possible, perhaps, that with an occasional boat putting in from this region a small amount of coal might be carried back, but only at very low rates. Under the circumstances, we can make no estimate of the amount of such traffic. Conditions are far better for the exports being made from the Atlantic ports. Much the same reasoning applies to the marketing of our coal in the Mediterranean région.

Exports of anthracite go almost wholly to Canada. Such other exports of anthracite as take place, for example to Cuba, would of course require no use of the St. Lawrence waterway.

Imports of either bituminous or anthracite are also wholly out of the picture.

Canada is, then, the only country to which we might ship coal via the St. Lawrence, and only a small portion of Canada at that. Though we send Canada practically one-half of the coal she uses, over four-fifths of this goes to Ontario and the head of the Lakes, regions which do not require use of the St. Lawrence. We can, then, practically limit this discussion to the Province of Quebec.[4] In 1925 Quebec had 4,755,000 short tons of coal available for consumption; in 1926, 5,310,000 tons. Complete data are not available for 1927. Of the coal consumed in Quebec in 1926, 1,968,000 tons came from other Canadian provinces, mainly Nova Scotia, 3,047,000 tons from the United States, and 210,000 tons from Great Britain.[5] Inasmuch

[3] See analyses of hides and skins, wool, sugar, lumber, fertilizer materials and iron ore, in other appendices. Any movements in of petroleum would be in tankers, which are not adapted to handling coal. Meat imports from South America would, of course, go to the deficit area along the Eastern Coast.

[4] The Maritime Provinces and Newfoundland use some American coal, but this is principally anthracite and therefore unlikely to move over the St. Lawrence. Nova Scotia soft coal is right at hand to supply such coal as Eastern Canada requires.

[5] Compiled from Dominion Bureau of Statistics, "Coal Statistics for Canada."

as deep-draft vessels can now penetrate the St. Lawrence as far as Montreal, it would be improper to impute to the St. Lawrence project now under consideration all such future waterborne traffic in Nova Scotia coal as might go up the St. Lawrence to that point. A large part of Quebec's imports of Nova Scotia coal is now received by rail, a fact having a bearing on the likely future use of the water route for such traffic. It is probable, however, that tramps, putting into the Great Lakes for grain, would occasionally pick up cargoes, or part cargoes, of coal for interior points. Under such circumstances even some British coal might be brought in.

Besides getting coal from the United States, Canada has her own western coal fields to draw on, particularly in Alberta. This western coal and lignite have never been able to move very far east, meeting coal from the United States no farther east than Winnipeg. Determined efforts have recently been made to better this situation through a subsidized rail movement into Ontario. Political, if not economic, conditions practically limit this eastern movement to Ontario; it could hardly be extended into Quebec, a natural market for Nova Scotia coal. An export movement of coal from western Canada is, of course, entirely out of the question.

Our problem becomes, then, one of determining the likely movement of anthracite and bituminous coal from the United States into the Province of Quebec via the St. Lawrence. To simplify matters, it will be assumed that Canada continues to permit the importation of coal without greater restrictions than those imposed by the present import duties. The power development which is a part of the St. Lawrence project and other power developments, particularly in Quebec, are, however, intended to render unnecessary the use of coal for other than house-heating and some public utility (gas) purposes. Hence the tendency may well be toward a reduction in the annual imports.

Of Quebec's 1926 imports from the United States 1,253,000 tons were anthracite coal and of her 1927 imports, 953,000

tons. The question here is whether coal would move from eastern Pennsylvania north and west to a lake port for delivery to boats, or go as now directly north for completed rail delivery. Certain of the anthracite carriers, such as the Lackawanna, would undoubtedly profit by the changed routing; others, as the Delaware and Hudson, would fight diversion; still others would have a divided interest. Transshipment would likely be at Buffalo or Oswego. The resulting route would be a roundabout one, involving a transfer at lake port and only a relatively short water haul from there on. With the exception of important cities directly on the St. Lawrence or within trucking distance, a transfer back to rail cars would be required to make completed delivery.[6] It is also to be borne in mind that there is something of a peak in anthracite production and that this comes in the fall and early winter months, during at least part of which period the water route would be closed. Proper price encouragement might, of course, move out a larger proportion during the open season than now goes at that time. The transshipment costs, the shortness of the water haul, the minor saving in rail distance, and the advantages of using regular routings all point, however, to the conclusion that significant use of the St. Lawrence for anthracite movements into Quebec would be unlikely. The predominantly outbound character of St. Lawrence traffic in general further strengthens our conviction that anthracite would continue to move almost wholly by rail. Boats of the size which it is hoped to attract to the St. Lawrence waterway would hardly pick up small lots of coal at Buffalo or Oswego and set them down at Montreal or Quebec. Smaller boats would be more likely to engage in such carrying, but these can now get over the St. Lawrence. No allowance need be made, then, for such small amounts of anthracite as might go down the St. Lawrence should the deepened waterway be provided.

[6] We pass over the fact that trucking to a retailer's yards is much more expensive than the spotting there of carloads.

Imports of bituminous coal into Quebec from the United States in the year 1926 amounted to 1,794,000 tons and in 1927 to 1,573,000 tons. Most of this coal moved in via all-rail routes from Pennsylvania, West Virginia, and Ohio, or by boat via Atlantic ports and Montreal.[7] How much of this would be diverted to the rail-water route which the deepened St. Lawrence would provide? The factors are much the same as those controlling the anthracite movement, though in this case the rail haul would be relatively less and the water haul longer. This advantage of the water route is very considerably diminished by the fact that during the peak of the coal movement the navigation season would be over or fast drawing to a close. Storage is expensive and results in deterioration. Production and consumption are linked very closely together. Marketing practices also exert a great influence on routings.[8] The marketing of coal is largely through jobbers, who, it may be supposed, will be more alert to take advantage of cheaper routings than retail dealers buying direct from producer. Routing is controlled by purchaser, not by producer; title passes as soon as the coal leaves the mine. This suggests the further consideration that if a cheaper route becomes available jobbers will as soon as possible switch their purchase contracts to the mines from which the lowest rate is obtainable; such a shift in production would not be so direct or complete if the producer himself marketed his coal directly. We should make allowance, however, for the fact that there are many grades of coal; it can not be handled as if it were a single commodity commanding a free movement in huge lots. It is also important to note that bituminous coal suffers both breakage and shrinkage with every handling.

[7] It is reported that 185,000 tons of coal moved over the St. Lawrence route in 1925.

[8] Some of the facts here used as to the marketing of coal have been obtained from C. E. Lesher's chapter on that subject in Spurr and Wormser, *The Marketing of Metals and Minerals*, 1925.

At the present time large quantities of coal are dumped at Lake Erie ports for shipment on the Great Lakes. Three factors encourage this movement: the need for upbound cargo for lake boats, the long water haul available, and the large lake and northwest market. That little coal enters Detroit by water is due to the nearness of Detroit to Toledo, Cleveland and other Erie ports; that Ontario is served principally by all-rail routes shows the combined effect of nearness, of the absence of a back cargo, and the costliness of one or two transshipments.[9] For these reasons and also the absence of any large cities either on the St. Lawrence or near it within the confines of Ontario, we can foresee no change in the present situation as the result of the deepening of the channel, so far as shipments to Ontario are concerned. Occasional small shipments will go down to such points, but none which need be attributed to the deepened channel. To Montreal and Quebec, the only two important river cities in the Province of Quebec, conditions are only slightly different. The market is larger, the water haul longer, and the total distance from point of production greater. But here American coal now encounters, and probably will continue to encounter in increasing degree, the competition of Nova Scotia coal, and increasing use of electricity will have some effect on the demand for bituminous coal.

It might be argued, as we have done in the case of anthracite, that it would be improper to impute to the St. Lawrence project now under investigation any additional coal traffic that might result from its completion. There is a difference, however, owing to the greater likelihood that bituminous, moving a greater distance by water, could and would become an in-

[9] From statistics prepared by the Ore and Coal Exchange, Cleveland, we learn that in 1925-27 an average of only 773,000 tons of coal went across Lake Erie to Canada. To Lake Ontario and St. Lawrence River Canadian points, the corresponding figure is 566,000 tons. There is no way of separating the latter figures between Lake Ontario and St. Lawrence River points. Seventy per cent of the 1925 movement was from ports west of Cleveland, particularly Sandusky.

tegrated part of a packet movement between Lake Erie and lower river points that cannot be conducted with the present limiting depth of the St. Lawrence channel. Thus, though such traffic would certainly not require a 25 or 30 foot depth, it may be considered contributory to the traffic that the larger project is intented to develop.

We may start, then, with a maximum demand in the Province of Quebec for 2,000,000 tons of American bituminous coal, approximately the average demand in 1925-1927 and, in view of the circumstances named a distinctly liberal figure. Probably a third of this should be eliminated on account of shipments via the Atlantic to Montreal and Quebec. At least half of the remaining 1,335,000 tons must in turn be eliminated to take account of shipments during the winter months, leaving 668,000 tons of potential traffic. But some of this would certainly continue to move all-rail to points not on the River or within the market zone of the river cities. Also that part of the Quebec imports purchased by the railroads would not utilize the St. Lawrence. Let us deduct a third on these two counts, leaving 450,000 tons of traffic to move from the interior of the United States during the period of navigation, to points in Quebec where the waterway service could offer some competition with rival means of transportation from the same general points of origin and with coal from eastern points whence use could not be made of the St. Lawrence. Bearing in mind all the marketing considerations hitherto enumerated, it is our best judgment that not more than 225,000 tons of coal per annum would move over the St. Lawrence to the points indicated. This figure is liberal enough to allow for the growth, small if any, that the future is likely to see. In addition, there would be small, local movements which would not be attributable to the deep waterway project now under consideration.

To allow for irregular shipments of Nova Scotian or European coals into the interior of Canada by boats putting into the Lakes for grain cargoes, we will increase our estimate of

inbound traffic by another 125,000 tons. The development of this traffic would be contingent upon very low rates.

Conceivably, bituminous coal could move either way between the Lakes and the Atlantic coast and anthracite could move in in that roundabout fashion. The bituminous movements would not, of course, be regular ones; they would have to be in the nature of ballast shipments. With a Middle West and an Eastern Coast region abundantly supplied with bituminous coal, it would be improper to accord such movements—a sort of "by-product" effect of the waterway—important weight in the final balancing of advantages and disadvantages of a deep waterway into the Lakes. As to the anthracite movement there are many unknowns. Certainly there appears to be no reason to expect any regular use of the roundabout rail-water route into the Middle West. The most that could be expected would be irregular shipments at low rates in boats putting into the Lakes after making New York or Philadelphia.

Coke exports to Canada averaged 757,000 tons in the years 1926-1927, but inspection of the points of export shows unmistakably that only a negligible amount went to the region along the St. Lawrence. Should Canada use coke more extensively as a fuel it would doubtless be through a large by-product coke oven development. In any event, coke represents small radius traffic, as a rule, and in so far as it supplants coal as fuel it also supplants it as traffic.

We can see no likelihood whatever of Middle Western coke going to such other countries as now purchase small quantities of American coke.

II. Petroleum and Petroleum Products

Here we turn to a class of traffic which is quite difficult to analyze. Present movements are quite clearly defined and certain shifts now occurring in the transportation of this class of products are discernible, but to bring into the picture an altogether new transportation route, as well as the many un-

certainties as to where our future sources of supply are to be, transforms the problem into one of uncommon difficulty.

There are two principal stages in the transportation of petroleum and its products: to refinery and from refinery. An initial movement to trunk pipe line or to railroad loading racks is also necessary, but with this gathering-in process we need not concern ourselves. A recent writer[10] classifies refineries on the basis of their location into (1) pool and district, (2) field, (3) market, and (4) seaboard or export. Classes (1) and (2), which appear to be quite similar, are smaller than the others and their advantage of location near the point of production of the crude oil is offset in most cases by their great distance from the market for their products. In fact, only such of their products as have high specific value can move any great distance in competition with refineries located in the market area; other products must be marketed locally. Though very numerous, these types of refinery have given way in large part to the other two. It has been found cheaper to move the crude petroleum to refineries located in the midst of a large market area than to transport the refined products long distances. Typical of market refineries are those in the Chicago district. Seaboard or export refineries are best typified by the gigantic units found at the Gulf ports. Sometimes a refinery is of more than one class. Thus the plants of the Standard Oil Company of New Jersey in New York harbor supply the big domestic demand and also do a large export business. On the other hand, its refinery at Providence is purely of the market type.

As is well known, our largest domestic sources of supply of crude oil are at present the Mid-continent and California fields, whose output far surpasses that of the older fields,—Pennsylvania, West Virginia, Ohio, etc. We also import large quantities of crude, almost wholly from Venezuela and Mexico, but with some coming from other countries in South America and the West Indies.

[10] Lilley, E. R., *The Oil Industry: Production, Transportation, Resources, Refining Marketing,* 1925, p. 438.

Crude oil from the Mid-continent field goes by pipe line to refineries situated at various points in the East, in the North Central states and the Middle West, and also to the Gulf for refining or for transshipment by tanker to other refineries, particularly our own Eastern coast refineries. Crude oil from California and Mexico moves by tankers to coast refineries. Though our railroads originated in excess of 11,000,000 tons of crude petroleum in 1925, their chief task is the movement of the refined products, of which they originated more than 46,000,000 tons in that year. Pipe-line transportation is much cheaper than rail,[11] but facilities are not always available, especially in the newer or smaller fields, and as a rule pipe lines are not used for the movement of refined products. Rail transportation of crude oil also is often more convenient, particularly for the small refiner, because of its greater adaptability to smaller size shipments. Though pipe-line transportation has largely superseded tank car for crude oil, it in turn has lost out greatly in recent years to the tanker. This last is a very efficient carrier. The larger ones have a capacity of from 70,000 to 110,000 barrels and the smaller ones, commonly used for short voyages, of 30,000 or more. Thus some of the big producers, while continuing to use their pipe-line facilities from the Mid-continent field to the Atlantic coast, are shipping to an ever greater extent by pipe-line to the Gulf and thence by tanker to Eastern refinery. It is to be noted, though, that the tanker does a one-way business, making quick turn-around very important.[12] This increase in the use of the tanker has

[11] The pipe-line rate on crude oil from the Mid-continent field to Chicago is 64¾ cents per 42-gallon barrel; the tank car rate is 29 cents per 100 pounds, equivalent to approximately 91 cents per barrel. To the latter figure would have to be added a gathering charge.

[12] A tanker of 90,000 barrels capacity handles the equivalent of 378 ten thousand gallon tank cars.

The Bethlehem Steel Company has designed a boat for carrying petroleum on the out voyage to South America and iron ore back, but such a practice could not become general.

a very significant bearing on our problem, as does the tendency, quite evident in the last few years, for the industry so to marshal its affairs (particularly by developing market refineries) that there may be a minimum of dependence on rail carriers even for the movement of refined products.

With this statement of preliminaries we are perhaps in a position to enter into a study of particular movements. We first shall examine the situation with respect to crude oil and then take up the refined and related products. This second group consists of a variety of commodities, such as gasoline, kerosene, fuel and gas oils, lubricating oils and greases, waxes, asphaltic and road oils, naptha, medicinal oils, etc. In analyzing both classes of movement we shall first examine the situation on the assumption of the pretty general continuation of present sources of supply, later taking up briefly the questions which would be presented if there should be radical changes in sources of supply.

(1) *Would domestic crude oils move out over the St. Lawrence route for export?* The answer seems obviously in the negative. The great points of exportation must continue to be the Gulf and California ports, which in 1925 accounted for over 99 per cent of our exports of crude. Mid-continent oil could not be piped to Lake ports and there be transferred to tankers in competition with oil of the same quality moved with a shorter pipe-line haul and over a wholly unrestricted water route. As a matter of fact, our exports of crude, though amounting to some 2,380,000 tons[13] in 1925-1927, have been more than three-fourths to Canada and the remainder have gone largely to regions easily reached from the Gulf or the Pacific Coasts. Europe takes less than 5 per cent of the total. In any event, our exports of crude are fairly certain to decline from present figures in the next few years. The movement into

[13] To secure comparability with our other analyses, all quantities have been reduced to short tons.

Canada will be taken up in connection with that into the interior of the United States.[14]

(2) *Would it be practicable to bring crude petroleum by tanker into the lake states and interior Canada for refining?* In answering this query we must observe the various points of origin.

(a) *Mid-continent oil:* From the northern part of the Mid-continent field (southern Kansas and northern Oklahoma) it is obvious that there could be no advantage in using a pipe-line-tanker route via the Gulf when a pipe-line haul of equal length would put the oil into the Chicago district and a haul of only slightly greater length would put it into other such important lake refinery centers as Toledo and Cleveland. From southern Oklahoma and Texas the answer is much the same. Here the direct pipe-line haul would be longer and that to the Gulf coast shorter, but there would remain the very long and circuitous tanker haul clear up and around, a one-way haul which under normal conditions could not give a net advantage over the direct route. The latter knows no seasonal problem, is continuously and intimately associated with regular marketing channels and manufacturing practices, and does not present the difficulties and costs of handling the huge, irregular offerings of crude which tankers would bring in. Collateral evidence supporting our conclusion is found in the fact that crude from the Mid-continent field still moves by pipe-line to the Atlantic seaboard, though the tanker haul there is fairly direct and not unduly lengthy. The addition of the several miles involved in getting into the Lakes would appear to be prohibitive, under normal conditions.

(b) *California oil:* Here the situation is different, owing to the fact that there are no over-land pipe-line facilities. The question becomes therefore one of the relative competitive positions of the various producing and refining areas, including

[14] It is perhaps unnecessary to state that, though of distinctly higher quality, the so-called " Pennsylvania " crude does not move in export to non-contiguous countries.

likely volume of production in the future. Were California to be our only source of supply there is no doubt that a tanker movement into the Lakes would take place. California crude now moves in ways which a few years ago would not have seemed likely. Thus it is tankered to Eastern Coast points and thence sent inland to points as distant as Pittsburgh, where it is able to compete with local or other oils obtainable there. California gasoline moves into the Middle West via Galveston. Prediction is extremely difficult and hazardous. Movements which could rightly be considered illogical if the exploitation of our resources and the development of our markets could be handled in an orderly fashion, do take place. Price and market conditions often send traffic to points where, theoretically, it should not go. It has been suggested to us, for example, that California or Mexican crude could be brought to East Chicago or Whiting, the boats taking from there a return load of refined products for the Eastern seaboard. The price situation might at times permit such an interchange, but we do not regard it as a necessary movement or one that would be in any sense profitable from the national point of view.[15]

If, however, California crude could be brought into the Lakes more cheaply than oil from any alternative domestic source of supply, such traffic could rightly be regarded as legitimate. Returning, then, to the question of practicability, we have these considerations to attend to: first, the great length of the journey, with no back haul; second, the seasonal closing of the route, making very extensive storage necessary and lessening very decidedly the efficiency of the tanker operation; third, irregularity of refinery operation or extensive storage even during the open season; fourth, the nearness of other sources of supply, particularly that which can go over-land; and finally,

[15] At the present time there is a surplus of refining capacity and of products in the great competitive market—Illinois, Indiana, Ohio, Pennsylvania, etc.—that tends to obscure the fact that in reality this is an area which must depend in largest part on supplies brought in from the various oil-producing regions.

the possibility of shipping crude to coast points for refining and shipment to the interior, or the shipment of the products of California refineries by tanker to Gulf ports for transshipment up the Mississippi Valley. Expert opinion seems divided, though it seems clear that the small refiner would be in no position at all to use such a route.[16] The large producers are represented in all the big production areas and all the refining and market areas; they therefore would not be driven into such a traffic movement by competitive forces such as would be set up if the sources of supply were mutually exclusive.

While not wholly confident of our result, we conclude that California crude would not move into the lake states by tanker, but that its natural movement would continue to be to the various coast refineries or in foreign trade. Support for this view is found in the fact that a typical tanker rate at the present time between the Gulf ports and North Atlantic ports is now 30 cents a barrel (with 23 and 38 cents the extremes), while from California ports to the same destinations a typical rate is 70 cents (with 59 to 100 cents the extremes). The spread between the two rates evidences the effect of increased length of haul. One of the largest and most experienced vessel operators has informed us that the expense of taking an ocean-going type of boat around into the Lakes would be altogether prohibitive, in competition with alternative routes. When conditions are extremely favorable—perhaps the coincidence of an oversupply of tankers of a size that could use the route[17] with a favorable price situation during the period when the route would be open—an occasional tanker might make its way around from California. Such a movement would be of too

[16] Aside from the fact that a tanker—even a small tanker—of crude would be difficult for the small refiner to handle, he would find it hard to purchase to advantage in so distant a market and to charter a tanker irregularly and yet on favorable terms.

[17] Even if the St. Lawrence had a depth of 30 feet it could not accommodate the most efficient type of tanker, which draws upwards of 28 or 29 feet. Some of the largest boats draw as much as 32 feet.

uncertain a character to permit of its being reduced to concrete figures; it might, in fact, be regarded as so "occasional" as not to be entitled to a place in our estimates.

(c) *Foreign crude oils.* Of our imports of crude oil in 1925-1927, some 9,700,000 tons, nearly 80 per cent came from Mexico and the Caribbean region, and the remainder almost entirely from South American countries. The Mexican supply is the only one requiring serious attention at this point; other future sources of supply will be examined later.

Mexican oil is a low value, asphaltic base oil not adapted, at least under present conditions of supply, to the production of the higher value products. It is characteristically used, after being slightly "topped" for gasoline, in the making of fuel oils and asphalt and road materials. One half the total is brought in at Gulf ports, in or near which manufacturers of asphaltic materials have large plants, and most of the remainder at Baltimore and coast points north. The nearness of the Gulf manufactories to the Mexican shipping points (mainly Tampico and Tuxpam), giving a quick turn-around for the tankers, the ability to operate on a year-round basis and to reach by rail a considerable part of the interior of the country from the Gulf ports as cheaply as it could be reached by rail from the lake cities, makes it fairly probable that a very considerable part of the supply would find its way, as now, in through the Gulf ports. As to Venezuela oil, most of it goes by tankers to refineries along the Eastern seaboard. Indications are that this will probably continue for some time to come.

Whether, under the circumstances, any Mexican crude would move into the Lakes for consumption as fuel oil or as asphalt in its various forms would depend on what savings, if any, over present routings would be possible, and on the likely demand in the Middle West for fuel oil. The latter is showing decided growth, uneconomical as it seems when the abundance of coal in this region and the possibility of working it up in the form

of gas for heating purposes is considered. The demand for fuel oil for heating purposes comes mostly in the autumn, winter, and spring months, which would require such extensive storage in the lake cities, if supplies were to be accumulated in the open season to last until spring, as almost in itself to negative the whole movement.

Our conclusions with respect to Mexican crude are, therefore, first, that it will continue to go in largest part to coast points, mainly across the Gulf but also to the north Atlantic; second, that as a fuel oil proposition it does not seem likely that any great use could be made of the St. Lawrence because the season is wrong; third, that there is a remote possibility that some Mexican crude would occasionally be shipped by tanker into lake ports.

We must briefly run over all three of the above major movements as they relate to Canada. Canada depends in very large part on other countries for her petroleum supply and by tariff regulations encourages refining within her own borders. Southern Ontario is the principal refining area.

Crude oil from the interior of the United States moves into Canada principally by pipe line, the cross-over occurring at Port Huron-Sarnia. A little Kentucky oil is barged across from Toledo and some oil moves by rail through Buffalo and adjacent gateways. A considerable amount moves over the northern border through North Dakota, Montana, and Idaho. Disposing of the easiest matters first, it seems too obvious to require proof that none of the oil to northwestern Canada would come from our interior via the St. Lawrence. As for movements into Ontario, these are unlikely to come from the west by tanker, for such a route would involve the major part of the present pipe-line haul and an unprofitable transfer to tanker and re-transfer in many cases on the Canadian side. If such a development were profitable it would have taken place long ago, for the St. Lawrence waterway would work no change

in the situation.[18] Would it, then, come from the lower Mid-continent field, from California, or from Mexico by water?

Much light is thrown on this question by the present practice of one of the large Canadian refiners of bringing Mexican and South American crude oils to Montreal, sufficient stocks being built up during the open season to carry over until the opening of navigation. Clearances from American ports (mainly Gulf and California) show an average of some 215,000 long tons carried to Montreal in 1925-1927, though this may consist in part of refined products. In all, the port of Montreal shows receipts of some 415,000 tons of crude oil in 1925, of which the American portion was about a third. With the St. Lawrence deepened, could this practice be extended to points which would involve use of that route? In answering this question we must bear in mind that Canada produces comparatively little of the petroleum she needs, and that therefore the alternatives are somewhat different in her case from what they are in the case of the American refiner. It seems likely that Canada would continue to get much of her supply by pipe line or other direct routes from the interior of the United States, but also that she will look to foreign supplies for her lower grades of petroleum and obtain some by tanker from the United States.

During the four years 1924-1927 Canada's imports of crude petroleum averaged 2,233,000 tons, of which less than two-tenths came from countries other than the United States. In 1925 total imports of crude petroleum equalled 2,150,114 tons, of which 313,000 tons came from countries other than the United States. With imports of 415,000 tons at Montreal in 1925, it is evident what amount of American petroleum is moving into Canada by water—approximately the 107,000 tons heretofore mentioned. Assuming present conditions of supply, we believe that a considerable part of Canada's imports of

[18] It is significant that only one of the large refiners has found it advantageous to operate tankers on the Great Lakes for the distribution of refined products.

crude might move into the Ontario refining district, though unlikely to go in the crude state to points beyond. With exhaustion of American petroleum, such movements would be likely to increase. Deducting amounts destined for Montreal and allowing for the seasonal factor so far as it is a factor in this case, we might set down as much as 500,000 tons of such traffic by 1940.[19]

3. *What is the possibility of exporting refined products via the St. Lawrence?* It seems fair to conclude, first of all, that the Midwest refineries, such as those at Chicago, are not the logical place from which to do our exporting. The various coast refineries have such distinct advantages that it would be unlikely that the inland ones could do more than an occasional bit of exporting. It would be wholly unnecessary to develop a water route to enable such exporting to be done. There may be, as we have been informed, a surplus of refinery capacity at some points on the Great Lakes, making an export outlet desirable from the refiners' viewpoint, but to provide a route because such a condition now exists would be quite without warrant. Assuming, as we may, a general representation of the big refiners in all the important fields and markets, we clearly can say that all of their exporting, except the most occasional or fortuitous, would be done from coast points. To repeat, this is not to say that some exports of petroleum products might not move out of the lake states, even to our Eastern Coast, but that such movements would be so incidental to the domestic business there done as not to be entitled

[19] This amount is computed by doubling the above 415,000 tons and by subtracting therefrom amounts that would move to Montreal and other points not requiring use of the St. Lawrence and for movements during the closed season. This estimate is contingent upon sufficient depth of channel being provided to accommodate a fairly large tanker. Thus we anticipate a fairly important and regular movement into Canada by water, whereas similar movements into the American interior, owing to differences in the supply conditions, would be irregular and unpredictable.

to serious consideration in a traffic analysis of the kind we are making.

To the above statements there is perhaps one fairly important exception. Some petroleum products now move by boat from refineries at lake cities to points on the St. Lawrence River. In 1925, 67,000 tons so moved. One of the large oil companies operates small tankers on the Lakes and serves a number of Lakes cities in this manner. This is, for the most part, a local movement, however, deliveries occurring *en route*, suggesting that even if deeper draft tankers could be used, there would still be advantages in using the smaller vessels. With Canada discouraging the importation of refined products it is our conclusion that only local movements would occur, not attributable to the deepened waterway.

4. *Would refined products move into the Great Lakes via the St. Lawrence?* As to the movement of refinery products in over the St. Lawrence from American refineries, obviously the only movements requiring consideration would be from our coast refineries. The inland refineries would not be able to engage in so roundabout a movement. Nor does it seem likely that the coast refineries could work out rates that would be attractive for such a movement. In all cases, particularly from the Gulf and the Pacific, the route would be a very lengthy and circuitous one, and the competition of supplies nearer at hand would be very difficult to meet.[20] It is also to be borne in mind that a very large part of the refinery products, particularly the low value ones, move direct from refinery to ultimate user, or small dealer, while others are sold in small lots that require

[20] The reader may suggest that the present movement of California gasoline clear around to the Eastern Coast and thence by rail to points as far west as Pittsburgh, where it undersells local production or supplies brought in from other regions, distinctly negatives this conclusion. A water rate of one cent a gallon is said to be enjoyed by this traffic. It is obvious, though, that the situation sketched is an abnormal one. California production is excessive and must be marketed somewhere. It is the view of experts in the traffic problems of the petroleum industry that this situation will right itself eventually.

close association of buyer and seller and are best adapted to frequent rail (often trucking) service. Use of the St. Lawrence route to an important extent in the open season and of other routes at other times would also very seriously affect the efficiency of use of tank cars, now owned or leased in such large numbers, and also put increased charges on the traffic that would move by rail at any time during the year. Only if tankers could take care of the peak could loss on the tank cars be avoided. There are marked seasonal peaks in the use of gasoline and of gas and fuel oil, one coming in the summer, the other in the winter. In either case the accumulation of supplies to last over the winter months would be wholly impracticable.[21] From the point of view of delivery time and convenience, there is no comparison whatever between rail and water carriage. The Standard Oil Company operates a fleet of barges on the New York Barge Canal, but this practice tells us nothing about what would take place in the way of the vastly different tanker movement over the St. Lawrence.

We do not regard it likely, then, that other than occasional, irregular use would be made of the St. Lawrence route for the movement of the products of our coast refineries into the Middle West. This competition might, however, be of sufficient potential strength to exert some influence over the price situation in the interior region.

5. *Would imports of refined products be available for the route?* Our imports of refined products other than gasoline and gas and fuel oil are of negligible extent at present. We imported in 1925-1927 an average of 770,000 tons of gasoline and allied products, of which over 90 per cent came from

[21] The stock of gasoline on hand rarely exceeds three months' supply and usually is from two to three months during the off-peak period and one to two months during the season of maximum use. Storage begins in the late winter and early spring months. Stock of gas and fuel oil run from one to two months' supply. Lubricating oil is stocked much more heavily. Crude oil, on the other hand, may be stored, in field or at ports, in large amounts—four months' supply or so.

Mexico and the Dutch West Indies and one-half through the Port of New Orleans, and some 487,000 tons of topped oils, including fuel oil, of like origin and moving through a great many Gulf and north and south Atlantic ports. A low rail rate is available from New Orleans to Chicago. In discussing heretofore the movement of Mexican crude petroleum we incidentally touched upon the question of gas and fuel oils. We noted the rapid increase in the use of oil for house-heating purposes, but also noted the effect of the seasonal character of this demand and the competition of other types of fuel. Our conclusion there that only occasionally would use be made of the St. Lawrence route applies here as well. We make no effort to estimate the extent of such use, owing to the irregularity and uncertainty which attend it.

As to gasoline, it seems quite unlikely that it could or would move from Mexico to the Great Lakes region, American or Canadian. Canada's imports of gasoline are almost wholly from the United States and her tariff policy discourages such imports. Gasoline has characterictically a short radius movement, as witness the development of market refineries with their varied array of by-products. It appears distinctly improbable, under present conditions of supply and price, that a long water movement of gasoline would take place.

6. *What will be the effect of changes in sources of supply?* As present sources of supply are exhausted and we turn to the wells of Colorado, Montana, and Wyoming, would not exportation by the St. Lawrence be probable? The answer is, no, because under the conditions assumed we would no longer be exporting. Exportation of refined products is as unlikely as that of the crude petroleum.

Should South American or Far Eastern sources be drawn upon, it is altogether likely that our imports would enter in the form of crude oil, with the refining done here. It would be quite uneconomical to refine abroad and bring the variety of products here. While speculation on the distant future of the

petroleum industry is very hazardous, the present indications are that the interior of the country will still have a supply of petroleum after the country as a whole is on an import basis. Consequently a waterway probably would not be an important factor in petroleum traffic until we reached the point when substantially all our supply of crude oil was obtained from overseas.

Should we ever come to the use of petroleum substitutes—alcohol, benzol, etc.—the sources of raw materials would be so problematical that prediction or discussion at this time would be futile. So far as coal derivatives are used, however, it is quite evident that the Middle West is well supplied with the necessary raw materials.

Canada, almost wholly on an import basis in the matter of petroleum and petroleum products, is in no position to engage in any important way in the exportation of petroleum products. The exports that occur represent mostly short movements into the United States or to Newfoundland. Only small, irregular shipments could go overseas. Her imports of petroleum products come practically in their entirety from the United States and so have already been considered. With the petroleum refining industry largely concentrated at inland points in Ontario (particularly Petrolia); and with smaller refineries at other places near the markets, there would be little opportunity to move petroleum products between domestic points in Canada via the St. Lawrence waterway. Some might move locally, but such traffic would not be attributable to the present waterway project.

Our general conclusion is, then, that use of the St. Lawrence waterway for the movement of petroleum and petroleum products would be distinctly limited and mostly "occasional" in character. The only clearly discernible movement would be that of crude petroleum imported by Canada from countries other than the United States.

III. Salt

To move any great distance salt must have very low transportation charges. It is the sort of commodity, then, which could use cheap water transportation to advantage. The American production takes place in central and western New York, in the vicinity of Detroit, Port Huron, Saginaw, and Ludington, Michigan, in northeastern and southeastern Ohio, in Kansas, Louisiana, the Great Salt Lake district, and along the California coast. In Canada production is mostly at Windsor, Ontario. The margin of profit in the salt industry is such that every possible saving in transportation costs is eagerly sought after, and there is a constant striving to extend the area over which sales are made. Especially true is this of the small producer, whereas the big one, with plants in many of the producing areas, is able to get into the various large markets to better advantage.

Michigan and perhaps northern Ohio salt obviously is the only American salt which might use the St. Lawrence waterway. New York salt can get into New York City by rail at the exceedingly low rate of 20 cents a hundred (80,000 pound minimum; 22½ cents at 45,000 pound minimum), and it can reach Boston for 22½ cents at the higher minimum. There would be no possibility of shipping this salt west to an Erie or Ontario port for transshipment by boat, either to a coast point or in export.

Where, then, could Michigan salt go? The idea apparently has been that it could reach New England and other coast points, there displacing salt which comes in from northern Europe, Mediterranean points, and the West Indies, as well as salt produced in New York state. Such a movement is not likely to be possible. The relatively small movement of salt on the Great Lakes now is part of our proof, though in itself not wholly convincing.[22] More specifically, we find the rate per

[22] Chicago received by water only 75,000 tons in 1923 and 46,000 tons in 1927, despite the fact that it is the leading salt-consuming point in the United States; Milwaukee received about half as

ton-mile on the salt received by water at Chicago (1923) to be 1.4 mills, that at Milwaukee 3.5 mills, and that at Duluth-Superior, 1.66 mills. These figures work out at $0.30, $0.99 and $1.245 per ton, there being considerable variation in the distance the salt was hauled. It would seem fair to conclude that packet boats picking up salt at Ludington, Saginaw Bay, Port Huron, or Detroit would have to have at least $2.50 per ton for deliveries to North Atlantic coast points. But New York salt can be laid down at Boston for $4.50 per ton and at New York City for $4.00. The differential would be, then, $1.50 to $2.00, out of which the Michigan salt would have to absorb movement charges (truck or switching) at loading and delivery end. It seems wholly unlikely that a rate over the St. Lawrence route could be made low enough to enable Michigan salt to be laid down at a profit along the Atlantic coast in competition with the New York salt. Furthermore, there is the foreign salt to contend with in seaboard markets. This comes in as a rule as ballast and can be sold at extremely low figures. When such supplies are available they completely dominate the market.

Finally as to exports: our biggest market is Canada, but the eastern part of Canada is well taken care of by New York salt, while serving the central and western part would require no use of the St. Lawrence route. Mexico, Cuba, etc., take moderate amounts of salt, but this would for the most part continue to come from Gulf ports. It is conceivable that, with a traffic interchange between the Great Lakes and the Caribbean region, some salt might move from the lakes region, but only irregularly and at very low rates.[23]

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much as Chicago and Duluth-Superior about 60,000 tons, and in 1927, 41,000 tons. Detroit sent 8 tons to Cleveland in 1922, but none in 1920 or 1923. Buffalo shipped 5,500 tons in 1920 and 246 tons in 1927. This indicates practically the entire Lake movement.

[23] Michigan is losing the lead as the most important salt producing state and some anticipate an absolute decline in its production in the near future. We mention this fact only as having some bearing on the situation as it may be in the more distant future.

Canada imports considerable salt from countries other than the United States, though in such irregular amounts that prediction is difficult. Her situation parallels that of the United States; any salt that might move in over the St. Lawrence coming right into the heart of the Canadian production. Under these circumstances, and owing to the likelihood that such salt would be ballast freight, we undertake to make no estimate of the extent of such movement.

IV. Clay and Chalk

1. *China clay or kaolin.* Kaolin is used extensively in the manufacture of paper (both as filler and coating), in the pottery industry for the whiteness it imparts, and as filler in paint, rubber, and oilcloth. Our imports of kaolin averaged 330,000 tons in 1925-1927, of which nearly 328,000 tons came from England. American supplies are abundant, however, and their use is likely to increase as the quality is improved and users become better acquainted with them. Our production, which is largely in Georgia, South Carolina, and Pennsylvania, increased from 150,000 tons in 1914 to 450,000 tons in 1927. The English clay, aside from being better esteemed by many users, is favored with low transportation charges. It serves as distress cargo and can therefore be laid down at our ocean ports at such a low figure as to make it difficult to market domestic clays in competition with it. New England ports, Philadelphia, and Baltimore account for considerably over 90 per cent of the imports.

There is reason to believe that some kaolin would move in over the St. Lawrence route, mainly as distress cargo. But various considerations indicate that such movements would not be likely to be extensive. (1) Established market practices give a decided advantage to the Atlantic ports. Brokers or importers there not only have well established trade relationships which others operating on the basis of a seasonal route would find it extremely difficult to break into; but they can reach

all the different regions—in the East and the Middle West—where china clay is used. Also, a very low rail rate is accorded this commodity. (2) Individual shipments to paper mills and other users are relatively small, rendering direct importation largely out of the question. Also, the mills often have to secure various grades of clay, a fact which further diminishes the opportunity for direct importation. (3) It is unlikely that extensive storage to enable the building up of supplies against the closed season would be practiced. There is the cost of providing clean storage and of tying up working capital, as well as the difficulty of forecasting what volume would be required some months in advance. Certainly the saving would have to be larger than could now be anticipated to warrant extensive storage. (4) The increasing use of domestic china clay makes it unlikely that our imports will show an important increase over a period of years.

If we assume a total importation of 400,000 tons per annum (a distinctly liberal base on which to figure) and that as much as a fourth of this would reach mills in the Middle Western states adjacent to the Great Lakes, we have 100,000 tons for further consideration. The various factors discussed above make it unlikely that more than possibly a fifth of this could or would use the waterway. Canada, which produces some china clay, has also imported some from England. A liberal estimate might place the total use of the St. Lawrence for imports of china clay at 25,000 tons per annum, of which 20,000 may be assigned to the United States.

Should we engage in the exportation of china clay, no use could be made of the St. Lawrence. Likewise, movements from Georgia and South Carolina to the various Middle Western consuming districts would almost certainly continue to be all-rail.

2. *Other clays.* Our imports of all other clays averaged about 65,000 tons in 1925 to 1927. England supplied three-fourths of our imports, with smaller amounts coming from other Euro-

pean countries, from British Guiana, and Africa. Over four-fifths enter via Philadelphia, Maryland, Virginia, New York, and New England ports. Some use is made of Gulf and Pacific ports. In view of the location of our ceramic industry, principally in New Jersey and eastern Ohio, it does not appear likely that any appreciable amounts of the imported English ball clay would use the St. Lawrence route. Nor is it likely that the high priced German clays, used in the manufacture of crucibles, glass-pots, and abrasives would use such routing. Common refractory or fire clay is being supplied more and more from domestic sources, which are abundant and widespread. Importations are likely to dwindle to very small figures.

Our exports of clays averaged about 80,000 tons from 1925 to 1927, divided about equally between fire clay and other clays. Canada is our chief market, taking three-fifths of the total. The movement into Canada would be likely to continue to be a direct rail one. Europe and Latin America take most of the remainder, but they are likely to continue to draw on Eastern and Southern points for their supplies.

Canada's exports of clay appear to be of small extent, and her imports are mainly from the United States.

3. *Chalk.* We import crude chalk, mostly from England and France, in amounts averaging 120,000 tons in the years 1925-1927; manufactures of chalk in an average amount of 7,000 tons, mainly from Belgium, England, and France; and talcum, French chalk, etc., to the extent of about 23,000 tons, mostly from Canada, Italy, and France. To a considerable extent ports other than New York are used in bringing this commodity in, indicating a decentralized marketing process. This factor suggests the possibility of using the St. Lawrence, at least in the case of crude chalk, if it could be brought back with a fair degree of regularity and certainty on return trips from Europe. Without attempting precision, we could put this potential use of the St. Lawrence route at not more than 20,000 tons per annum, in which figure ample allowance has been made for future growth in imports.

Our exports of chalk are of small extent and go mainly to Canada, though also to the countries to the south of us and the Far East. No use of the St. Lawrence is indicated for this type of business.

Canada's exports have gone wholly to the United States and as these originate at a point in Ontario near Lake Ontario, no use would be likely to be made of the St. Lawrence route. Her imports are small and come mainly from the United States.

V. Glass, China, Porcelain and Earthenware, Bricks, and Tile

1. *Glass and manufactures of glass.* This group of products enters into foreign trade in rather large amounts. Our best markets are found in Latin America and to a less extent in the Far East, with Canada of importance as well. Europe takes very little. This location of our markets, when taken with that of the industry, clearly indicates that little use would be made of the St. Lawrence route for exports. Pennsylvania and West Virginia are the two leading states in point of production, with New York, New Jersey, Indiana, Illinois, and Ohio also important. Most of the production in the three states last named is, however, at points which would require a rail haul to lake ports. Moreover, many of the plants in these states are owned by concerns having plants elsewhere which can be more conveniently used for exports, and some are small concerns which do not engage in an export business.

Everything points, therefore, to the extensive use of Eastern, Southern, and Western plants for the export trade (except that to Canada); in so far as Middle Western plants are used, their products, particularly the lower grade ones, would doubtless flow directly south and west, and, to some extent, east for shipment via New York and adjacent Atlantic ports.[24] Nor are

[24] For example, the rate on glass bottles from Huntington, West Virginia, to Toledo is 25 cents a hundred as compared with 32 cents a hundred to the Atlantic seaboard. Clearly, so small a differential could not be attractive either to the vessel lines, or, in view of the service required, to the shipper.

shipments into Canada likely to require or permit use of the St. Lawrence. The only low grade glass product we send to Canada in any amount is glass containers (bottles, etc.), but this traffic is likely to continue to use all-rail routes direct from factory door to destination. There could be no saving in sending it by a roundabout rail-water route.

Coastwise also there is little or no likelihood that use would be made of the St. Lawrence route. Here again plants nearer the coast would be used in large part, while interior plants, which in most cases would have to use rail service in reaching a lake port, would be discouraged from routing in such an indirect fashion. Oftentimes shipments must move rapidly and orders are placed with no particular regularity, thus making the establishment of trade connections and shipping arrangements dependent on a roundabout and seasonal water route, with infrequent service, quite unprofitable. Storage is not practiced to any great extent. Occasionally, shipments might find their way over the route, but such traffic would be too irregular and inconsequential to include in our final estimates.

Our imports of glass and manufactures of glass averaged approximately 135,000 tons in 1925-1927. Practically the entire supply came from Europe, particularly from Belgium, Czechoslovakia, Germany, France, and England. There is a very great variety of imports, ranging from plate glass to cut glass and electric lamp bulbs. The most important item is plate glass, for which the automobile has created a great demand. Of this we imported some 100,000 tons in the years indicated. It is likely that some of the large producers of automobiles and automobile bodies would make use of the St. Lawrence route in bringing in Belgian and other European plate glass. No extensive storage would take place and considerable use would continue to be made of other routes even during the open season. It is also possible that dealers in glassware of all kinds, particularly the cheaper grades, would find it possible at times to route their imports direct, as in stocking up for a seasonal

trade, etc. Without attempting a refined analysis, but applying principles and facts developed elsewhere, we can set down 20,000 tons per annum as the maximum use that could be made of the St. Lawrence in bringing in glass and manufactures of glass. Of this the greater part would be plate glass. In allowing for growth in deriving this figure we have been liberal in that, with the American industry better able than at present to cope with the demand, it is likely that less dependence on foreign supplies will be necessary. There are also tariff complications in the case of all our imports of glass and glass products.

Canada's imports of glass and products of glass from countries other than the United States have probably averaged close to 25,000 tons in recent years. Her exports have been much less extensive. In all, 10,000 tons might be included in our traffic estimate as a maximum figure.

2. *China, porcelain, and earthenware.* The only items of export requiring serious consideration are electrical porcelain and earthen, stone, and crockery ware, of which together we exported an average of 21,000 tons in 1925-1927; and sanitary earthenware, lavatories, toilet bowls, and sinks, which we exported to the number of 81,000 on the average in 1925-1927. China and porcelain table, toilet, and kitchen ware goes out in small quantities and would not be likely to make use of the waterway. Canada takes one-third of our total exports and Latin America most of the rest, Europe and the Far East being important only in the case of electrical porcelain.

Porcelain electric supplies (mostly insulators) are produced largely in New Jersey and Ohio, with West Virginia, New York, and other states also important. The Ohio production, which alone could furnish any large traffic for the waterway, takes place at points not on the Great Lakes, necessitating in many cases a rail haul to port. As a rule, this class of traffic moves irregularly and orders must be got under way promptly. Under these circumstances it does not seem likely that any appreciable use could be made of the waterway, owing to the negligible sav-

ing, if any, in transportation charges, and the poorer service available from the lake ports.

With our markets for earthen, stone, and crockery ware almost wholly in Latin America and Canada, there is little likelihood of use being made of the St. Lawrence, despite the fact that production of such goods occurs predominantly in Ohio with two or three other Middle Western states of at least some importance. The reason is partly the location of the industry within the state—practically all the plants are at a distance from a lake port—and partly the infrequent and time-consuming service likely to be available between the lake ports and Latin America. Movements into Canada would be all-rail after so long an originating rail movement.

Our market for sanitary earthenware, lavatories, toilet bowls, and sinks is also largely in Latin America, with Canada and the Far East of minor importance and Europe taking very little. Production in 1923 was about two-sevenths in the states adjacent to the Great Lakes, but very largely at points which would require a rail haul in reaching shipside. The fairly frequent and regular service required is not likely to be available, certainly not from any of the less important lake ports. There is no particular seasonality of shipments. Under these conditions, it follows that such use as might be made of the St. Lawrence route would be almost wholly "occasional" in character and very limited at that. Shipments would not be held back during the long intervals between boats. It also is fairly clear that in the case of the greater part of the Ohio production the route could offer no attractions from a rate point of view. At least one of the most important Middle Western producers has plants in the East which would be used for the export trade. We can set down no figures under this head.

What was said about the intercoastal movement of glass and glass products applies equally here. No consequential use could be made of the St. Lawrence route.

Our imports under the general head of china and porcelain ware aggregated 55,000 tons in 1925-1927, of which about 70

per cent came from Europe and 26 per cent came from the Far East. The most striking aspect of these imports is their wide distribution over the various ports of entry. New York accounted in 1925 for only 37 per cent, while such a port as Baltimore acounted for 14 per cent and the Pacific coast ports for 21. Ten per cent of the entries were credited to interior customs districts. This evidences a type of traffic which seeks minor savings in transportation charges and is able to put up with inferior service. The large wholesale and mail order houses and possibly some of the larger retailers (for example, five- and ten-cent stores) could make direct importations during the season of navigation, though they would be unlikely to rearrange their purchases in order to crowd deliveries into the season of navigation. Under these circumstances, we regard it as likely that a considerable part of the imports from Europe would move directly and perhaps a small part of those from the Orient. An allowance of 10,000 tons per annum under this head appears to be reasonable.

Canada's imports of china and earthenware have exceeded 10,000 tons in recent years. The greatest part of these would doubtless continue to enter at Montreal for distribution from there. But it is conceivable that as much as a fourth of Canada's imports, or, allowing for growth, about 4,000 tons per annum, would move directly to interior points via the waterway. Her exports of china and earthenware are not extensive and no estimate on our part is necessary.

3. *Brick and tile.* Our exports of refractory brick and shapes and of tile go almost wholly to our neighbors, Canada on the north and Mexico, Cuba, etc., on the south. Production of firebricks is scattered, with Pennsylvania, Missouri, and Ohio leading. The only possible movement over the St. Lawrence would be that into Canada, but it is fairly certain that, with an originating rail haul of considerable length on shipments from Pennsylvania and Middle Western states, there would be no incentive to transfer to boat for the remainder of the distance. Transfer charges are too heavy, with trucking or rail charges at

the other end. The same may be said of building brick, which move only short distances as a rule, and of hollow tile and wall and floor tiles. In no case is more than an unimportant local water haul into Canada likely to take place.

Our imports of bricks—more than four-fifths from Europe and the rest from Canada—were valued at $676,000 in 1927. Those from Canada would for the most part move across the boundary into adjacent industrial districts; no use of the St. Lawrence is likely. It is possible that the Middle Western steel industry would import some of the special grades obtainable in Europe, though the general run of the European production could not penetrate to that region. The amounts at best would be small.

Our imports of tiles, including wall and floor tiles, amounted to 5,255,000 square feet in 1927, or, at an assumed weight of 12 pounds to the square foot, to about 30,000 tons. England, Germany, and other European countries are the chief source of supply. Here again it is possible that some direct importations into the lake states of building and wall tiles would take place, but, owing to the relatively high grade of such traffic, the great variety of tiles and, in general, the smallness of the individual tile business, it is doubtful whether any significant proportion of our imports would be diverted from New York and other Atlantic ports. To be liberal, however, we will set down 2,000 tons per annum as a maximum figure for such direct imports.

Canada appears to export little under the head of tiles and fire and other brick, except to the United States and then only in small amounts. Her imports come for the most part from the United States and therefore were considered above. Her only other imports of firebrick and related products are from England; these averaged $170,000 in value in the years 1925-1927. Assuming that these brick, which are of very high quality, had an average value of about $100 per thousand, we have here about 7,500 tons of traffic. Doubtless a considerable part of this could move directly into the interior of Canada,

though presumably at low vessel rates for a large part of the traffic. Allowing for growth, we may set down 4,000 tons of traffic per annum under this head. This figure is distinctly liberal.

VI. Magnesite, Magnesia, Graphite, Mica, and Carbon

1. *Magnesite.* Magnesite is marketed in two forms, dead-burned, used principally by the steel industry for its refractory properties, and caustic calcined, used as a plastic material in the manufacture of cement floors and walls.[25] Production in this country, in California and Washington, was stimulated by the shutting off of imports during the World War. Since the war, imports have picked up again, in recent years averaging about 75,000 tons per annum. Dead-burned magnesite comes from Mediterranean Europe, and the caustic calcined from India and Greece. Canadian output is relatively small, averaging 4,350 tons in 1922-1926.

The market for magnesite as a refractory material is principally the steel district between Baltimore and Chicago. The magnesite used for this purpose, now almost wholly imported, originates in Austria. It is said that because of the development of substitutes and for other reasons, this demand has reached its peak. If our Western magnesite cannot compete with the foreign along the Eastern seaboard, it seems altogether unlikely that it would be able to move inland via the St. Lawrence route.

The question as to how imports would move is more difficult. The dead-burned magnesite can be stored without injury. Whether any considerable part of it would move during the open season would depend, then, very largely on marketing practices. It has been suggested by some of the traffic representatives of steel companies in the Middle West that magnesite could be imported in pooled cargoes and that as much as 15,000 tons annually could be brought in in this manner. Others have

[25] Use has been made of R. W. Stone's chapter in Spurr and Wormser, *The Marketing of Metals and Minerals,* 1925.

expressed a preference for present methods of importing this material. If some coöperation of this sort could be secured, it is possible that as much as 10,000 tons per annum would be imported directly; otherwise, present methods of importation would be likely to continue in the main, with occasional lots coming in as back loading and at low rates. Such traffic would not be likely to exceed 5,000 tons per annum. In view of the tendency for imports to decline in years to come, owing to the growing use of substitutes, the latter figure is used in our final estimates.

The market for the caustic calcined product is country-wide. At present California, the Chicago district, and the New York-Philadelphia district are the chief centers of consumption, but the demand should grow in all parts of the country. New uses for the product are being developed. Our present domestic supplies are of limited extent and find their best market in the West and Middle West; the Eastern market is largely taken care of by imports from Greece. Whether, any of our importations would be diverted to the St. Lawrence route is problematical. Storage for long periods is not possible as it is in the case of dead-burned magnesite; sales are in relatively small lots; the present well-established market practices would be likely to continue to be effective; and vessel service between the Mediterranean region and the Great Lakes is likely to be very infrequent. Inasmuch as our total imports of magnesite of this kind do not exceed about 20,000 tons, it would be distinctly liberal to estimate that as much as 2,000 tons per annum would make use of the St. Lawrence route. This would come almost wholly from Greece and there is a distinct possibility that marketing practice would not adapt itself to permit even this amount to come in via the waterway.

Canada's exports of magnesite are largely to the United States. Production is wholly in the province of Quebec, and since transshipments would be involved, no use of the St. Lawrence is indicated. No imports are recorded in the available statistics.

2. *Magnesia and manufactures thereof.* The principal item here is calcined magnesia, used largely as an insulating material. Exports amount to only a few thousand tons, with Canada taking more than half and Latin America most of the rest. This location of our markets, together with the high value of the product, gives indication that use of the waterway, except perhaps "occasionally," would not be feasible.

Imports are negligible in extent.

Canadian foreign trade in this product is negligible.

3. *Graphite or plumbago.* Our imports of this commodity have run between ten and twenty thousand tons in recent years and have originated largely in Mexico and the Far East, particularly Ceylon. Leaving aside imports from Mexico and Canada, fully 95 per cent of our imports have come in via New York. It is altogether probable that such would continue to be the case, distribution from there to manufacturers of crucibles, paints and other products being easily effected. Imports from Mexico flow across the southern border and would not be diverted to any other route.

American production and exportation of graphite are of small extent from a tonnage standpoint. Their wide distribution, both in the unmanufactured and the manufactured form, including crucibles, together with their high unit value, makes it altogether unlikely that any use would be made of the St. Lawrence route.

Canada's exports go practically in their entirety to the United States and would move all-rail. Imports appear to be of very small extent.

4. *Mica.* Our total imports of mica, in either its crude or manufactured form, have been only about 3,500 tons in recent years. These have originated largely in British India and Canada, with Latin America and Europe minor sources of supply. Trade and shipping practices make it altogether unlikely that imported mica would use the St. Lawrence route. Our domestic production is principally in North Carolina and New

Hampshire, with a number of other Southern and some Western states also a factor. But here again our exports are small and their use of the St. Lawrence route is favored neither by location of producing points nor by the governing trade conditions.

Canada's foreign trade in this product is very largely with the United States.

No allowance can therefore be made under this head.

5. *Carbon and carbon products.* The best market for our carbon products (electrodes, etc.) is Canada, which has recently taken nearly three-fourths of the total. Movement into Canada would not admit of use of the waterway. The remainder of our exports—some five or six thousand tons in recent years—go out almost entirely through New York. This indicates manufacture very largely in the North Central and Eastern states, and centralized marketing. The service requirements of this traffic are also high. For these reasons, no significant use of the waterway is probable.

Our imports are of small extent and are largely of European origin. New York is the one important point of entry and, considering marketing practices, the locations of the industries using carbon, and the character of the traffic itself, it appears that little or no use would be made of the waterway.

So far as available statistics show, Canada obtains most of her supply of carbon and carbon products from the United States. Under these circumstances, exports would be negligible in extent.

VII. Asbestos

We import a large amount of unmanufactured asbestos (an average of some 212,000 tons for the years 1924-1927), but practically all of this comes from mines in southern Quebec between the St. Lawrence and the international boundary. The production of asbestos products in our Eastern states (especially Pennsylvania, Massachusetts, and New Hampshire) far exceeds that in any other part of the country. The rela-

tively small amount of the Canadian crude asbestos that moves west to important plants in Milwaukee, the vicinity of Chicago, etc., is likely to continue its present all-rail movement. A rail haul to Montreal and water haul thence, with double transfer charges, could scarcely compete with the frequent, regular, and dependable rail service. Some domestic asbestos is also available for the Middle Western plants.

Canadian exports of asbestos and manufactures of asbestos to countries other than the United States also would involve no use of the St. Lawrence, since they would be made from Montreal or points east thereof.

There are said to be asbestos deposits in Wyoming. These are wholly undeveloped as yet, making it impossible to form any judgment as to what traffic, if any, they might eventually afford.

Our imports of manufactures of asbestos are fairly extensive (some 38,800 tons in 1925-1927) and come almost entirely from Europe, particularly Belgium. The very considerable use made of our secondary Atlantic ports, particularly Philadelphia, and of Gulf ports, appears to indicate that this is a type of traffic which could move into the Middle West directly by water. Marketing considerations are important, and there are also, of course, the closed season and the infrequency of liner service into the Lakes to consider. In all, perhaps 2,500 tons could be credited to the St. Lawrence.

Our exports of manufactures of asbestos (except roofing), including also a little unmanufactured, averaged 6,000 tons in 1925-1927. Canada is a fair market and Europe generally a small one, while Latin America and the Far East are of greatest importance. There is, however, such a variety of products here, the scatter of our exports is so great, production is so predominantly in the East (from which waterborne exports could most easily be made), and this type of traffic requires so high a grade of transportation service, that it does not appear likely that any but an "occasional" use of the waterway could be made.

Canada's imports of manufactures of asbestos, other than from the United States, are small. To be liberal, however, we will set down 250 tons of traffic for the St. Lawrence under this head.

There would be no occasion to use the waterway for either American or Canadian domestic movements of asbestos and its manufactures. Either the situs of supplies prohibits, the coast and lake regions are able to meet their own demands, or other routes and a better type of transportation would attract the traffic.

VIII. Abrasives and Abrasive Materials

Though there is quite a variety of products under this head, only a few require much consideration, the rest entering into trade in only small amounts.

Emery and corundum, at one time of exclusive importance, have given way in large part to so-called artificial abrasives. We imported on the average in 1925-1927 some 5,000 tons of emery ore, largely from Turkey and Greece, and about half that amount of corundum ore, chiefly from various parts of Africa. Both are brought in at the New England ports, New York, and Philadelphia, and some corundum moves across from Canada at Buffalo and St. Lawrence points. It is fairly certain that the small amounts received from Canada would continue to enter the United States by rail. Nor is it likely that the materials from other foreign countries, used so extensively in New York State and New England, would make any appreciable use of the St. Lawrence route in entering the United States. The same may be said of pumice stone, which uses New York almost exclusively as the port of entry.

Some flint pebbles have been brought into the Lakes by the small Norwegian boats which can now navigate the St. Lawrence. The points of origin are mainly France, Denmark, and Belgium. Our total imports of flint and flint pebbles have aggregated about 15,000 tons in recent years.

Without continuing the analysis further, we might conclude that, under favorable circumstances, as much as 5,000 tons per annum of the above and other miscellaneous abrasives and abrasive materials would make use of the St. Lawrence. Of these, flint pebbles would be the most important. This estimate is liberal and allows for such growth as may be expected.

The really important items of traffic consist of the crude materials (carbides of silica, aluminous abrasives, etc.) from which artificial abrasives are made. Of these we imported an average of about 50,000 tons in 1925-1927, almost wholly from Canada but with some coming from France and other European countries. The movement from Canadian points of production would, however, tend to be directly north and south rather than east and west, making use of the St. Lawrence impracticable. Any of such materials as might move into the interior from Europe would, at best, be of slight extent.

Our exports of abrasive materials and finished abrasive products averaged 23,500 tons in 1925-1927. In general, these go to a wide scatter of countries. The leading states in production are New York and Massachusetts, with Pennsylvania, Illinois, and Ohio also important. The biggest single point of production appears to be on both sides of the international boundary at Niagara Falls and in that vicinity. This is a class of traffic that goes in rather small amounts and requires rapid and dependable service. In view of these facts and the infrequency of the vessel service likely to be available over the St. Lawrence route, we conclude that, should any use be made of it for exports of these products, such use would be only "occasional" in character and therefore not entitled to a place in our final estimates. At best it could not exceed one or two thousand tons per annum.

Canada's exports go almost wholly to the United States and are not likely to permit of any important use of the St. Lawrence waterway. So far as known, Canada is not an importer of abrasive materials.

IX. Fuller's Earth, Feldspar, Fluorspar, and Cryolite

1. *Fuller's earth.* Fuller's earth is used chiefly as a filter in decolorizing and clarifying vegetable, animal, and mineral oils.[26] Production in the United States averaged about 235,000 tons in 1925-1927, and takes place almost exclusively in the South, particularly in Florida and Georgia. Small amounts are obtained in Illinois, Pennsylvania, Massachusetts, and California. Though our deposits are fully capable of meeting the domestic demand, small amounts (some 8,000 tons on the average in recent years) are brought in from England and consumed along the North Atlantic coast. The Florida production is used by the petroleum refineries (though to a decreasing extent) and goes all-rail or by rail-water to points along the East Coast, to the Midcontinent field, and elsewhere.

The difficulties encountered by the Florida product in meeting British competition along the Eastern Coast suggests very strongly that a combination rail-and-water route into the Middle West via the St. Lawrence would offer slight, if any, advantage in rates and certainly none in service, over the all-rail route. Owing to this fact, the relatively small size of individual shipments, and the rather high value of the commodity itself (somewhere around $18.00 per ton), we do not regard it as likely that fuller's earth produced in Florida could use the St. Lawrence route to advantage. That produced in Georgia, Arkansas, and Texas, used principally in the vegetable and edible oil industries, is for reasons of distance wholly unlikely to make use of the St. Lawrence route. The California production is absorbed locally.

The only likely movement over the St. Lawrence, as we see the matter, would be from England. Assuming that a fair amount of vessel service requiring back loading would be available from that country, we might estimate that 2,500 tons per annum would pass over the St. Lawrence route, a figure in

[26] Spurr and Wormser, *The Marketing of Metals and Minerals,* 1925, p. 326.

which allowance has been made for such growth as may be possible in the face of an expanding domestic production. We do not place the figure higher because of the general location of the vegetable and edible oil industry (with the exception of linseed oil) at points not adjacent to the Great Lakes.

Our exports are of negligible extent, and in any event would not require use of the proposed waterway.

Reasoning as above in the case of imports from England, we may set down 500 tons of Canadian traffic under this head.

2. *Feldspar.* Feldspar is used chiefly in the ceramic industries. It is mined at no great distance from the coast in New England, and in New York, Pennsylvania, Maryland, and North Carolina. A considerable amount is imported from Ontario and Quebec. Grinding is done both at railroad stations near mines and at distributing centers.[27] Canadian feldspar is ground at such points as Trenton, New Jersey; Cleveland and Silica, Ohio; Wheeling, West Virginia; and Lewiston, Pennsylvania. Production in the United States averaged 200,000 tons in 1925-1927, and about 36,000 tons in Canada. The United States has taken practically all of Canada's exports and very nearly all of her production.

Relating production point to consumption areas, we find little or no occasion for use of the St. Lawrence route. The Canadian mines are largely near the eastern end of Lake Ontario. In view of the necessity of an originating rail haul from mine, the great roundaboutness of the St. Lawrence route compared with the all-rail one to the New Jersey pottery district, and of the advantages (regularity, certainty, speed, and completeness) of rail service, it does not appear likely that any feldspar would find its way into the United States via the St. Lawrence.

Our exports are of negligible extent.

3. *Fluorspar.* Fluorspar, or fluorite, used largely in metallurgical work and to a less extent in the manufacture of opalescent

[27] Spurr and Wormser, *The Marketing of Metals and Minerals,* 1925, p. 305.

glass, enameled ware, emery wheels, chemicals, etc., was imported in an average amount of 63,000 tons in 1925-1927, from England and Europe and to a less extent from Africa. It is a low value commodity which must have low transportation rates for movement over any considerable distance. Domestic supplies, which are fairly abundant, are obtained principally in southern Illinois and northern Kentucky, with small amounts coming from Colorado, New Mexico, and a few other states. Exports are small—some 1,200 tons in recent years. In view of the location of the mines, the secondary Atlantic or the Gulf ports are more likely to be used for our waterborne exports than a lake port and the St. Lawrence, while movements into Canada would be by rail rather than by water.

Our imports in this case, if they are to penetrate into the lake region, would have to come at very low transportation rates and almost as distress cargo. It is not unlikely that some such movements would take place, owing to the necessity of getting back loading from England and the Continent. Such movements would more commonly, of course, reach our Atlantic ports. No great growth of imports under this head can be anticipated, owing in part to the expansion of domestic production. Under these circumstances, an estimate of 7,500 tons per annum seems liberal.

Canada's production of fluorspar, in Ontario, is of very slight extent. No statistics of her imports are available. Apparently, these are small and use of the St. Lawrence would be of slight extent.

4. *Cryolite.* Cryolite is used principally in the aluminum industry and to a minor extent in the manufacture of opalescent glass and enameled ware. Our imports, which averaged about 7,500 short tons in 1925-1927, are obtained almost entirely from a Greenland deposit. The entire movement from Greenland is to Philadelphia. This we regard as likely to continue to be the case, for no boats would be apt to ply between Greenland and the Great Lakes. There is also relatively little occasion to

use cryolite at lake ports; hence the domestic distribution from Philadelphia to points of consumption would in all probability continue to be an all-rail one. No traffic for the waterway is foreseen.

The situation seems to be much the same in the case of Canada; little cryolite would be likely to penetrate directly into the Lakes.

X. Sulphur and Pyrites

1. *Sulphur.* In many ways sulphur is ideally suited to using such a transportation route as the St. Lawrence. It is of a low value, is adapted to bulk shipment, can be stored at little expense, and hence could be moved very largely during the open season. Its production is so highly concentrated that maximum advantage could be taken of any transportation savings that might be possible.

More than 99 per cent of the sulphur is produced in a small coastal area of Texas and Louisiana and is in the hands of but three companies. Exports, which averaged 665,000 tons in 1925-1927, absorbs a third or more of the production. Sulphur enters into the manufacture of acids and chemicals (30-40 per cent of total), fertilizers (25-35 per cent), paper (20-30 per cent), and explosives and miscellaneous articles (6-14 per cent).[28] Production is on an all year round basis, necessitating extensive storage at the mines. Some storage is also practiced by the industries using sulphur, but the fertilizer demand has a marked peak in the fall and late winter months. The great domestic markets at present are in the East (paper and chemicals) and in the Southeast (fertilizers); the Great Lakes and Pacific coast regions are less important. Sales are commonly made direct to consumers.

It is our conclusion that a portion of the sulphur destined for Lake Erie and Lake Ontario ports would use the St. Lawrence waterway, but that none of this commodity destined for

[28] Spurr and Wormser, *The Marketing of Metals and Minerals,* 1925, p. 551.

Chicago and other interior cities would utilize this route. We may give the reason for this second conclusion first. The present all-rail rate from Gulf Hill, Texas, to Chicago is only $7.00 per ton as compared with rates via New York and the Erie Barge Canal to Cleveland, of about $8.00 per ton. Moreover, the Mississippi River, if transportation conditions thereon are improved, would offer a much cheaper route than the roundabout St. Lawrence.

Sulphur destined for points on the lower lakes now has the alternative of going by rail direct from point of origin in Texas to lake cities, or by rail to Galveston, thence by ocean vessel to New York, and by barge canal to Lake Erie or Ontario ports. The rate by water is slightly less than by rail. It is obvious that the New York-Erie Canal route has an important distance advantage over the St. Lawrence route, though perhaps not sufficient to offset the cost of transshipment to barge at New York and the somewhat higher rates by barge canal. Boats bringing sulphur into the Lakes by way of the St. Lawrence would, however, have no adequate return cargo. A large part of such shipments as are made from the Great Lakes to the Caribbean region consists of high grade commodities requiring regular and frequent service; hence they would not move via such a roundabout route as the St. Lawrence. On the other hand, the boats which bring sulphur to New York have a back-haul to points like Havana, whence it is about four and one-half days' sailing to Galveston, the principal loading point for sulphur. Consequently, ships carrying sulphur into the Lakes would be at a disadvantage as compared with those entering New York and rates would, therefore, have to be higher in proportion to distance.

Precise estimates of the relative costs involved are impossible to make. But we are inclined to believe that the greater part of this traffic will continue to move into the Lakes by way of New York or direct by rail. We estimate that the total United States consumption as of the year 1940 will be approximately 2,000,000 tons. Of this amount, something like 150,000 tons would be con-

sumed in, or close to, Lake Erie and Lake Ontario cities. If we assume that as much as half of this might come in by way of the St. Lawrence route, we would have a liberal estimate of 75,000 tons.

Canada has received from the United States an average of 150,000 tons of sulphur in 1925-1927. Some of this goes to western Canada, some would not move by water beyond Montreal, and some would naturally continue to move through interior gateways (Michigan and Ohio, etc.) during the winter months. Also some would pass into Canada via the New York Barge Canal. In fact, Canada's paper-making, chemical, and allied industries are largely in the East, while her agriculture is to a considerable extent beyond the reach of the St. Lawrence in this instance, in that an expensive rail haul, added to a long, roundabout water haul, would total up to a point where it would be cheaper to use other materials or to go without. Allowing for a growth of 50 per cent in Canada's total importations by the year 1940, we may estimate that perhaps 40,000 tons of sulphur would find its way in over the St. Lawrence route.

2. *Pyrites*. Our imports of pyrites, which averaged 980,000 tons in 1910-1917, in the five years 1923-1927 averaged under 300,000 tons. Practically all come from Spain, though Canada has sent us irregular, but usually small, amounts. At any rate, it is only the Spanish pyrites which require attention here. As already stated, these come in usually as distress cargo. As would be expected, they enter at the secondary ports, such as Philadelphia, Baltimore, Norfolk, and Pacific coast ports. Relatively little comes in at New York. There is some domestic production of pyrites, particularly in California, Virginia, New York, and Colorado. It is not generally considered that the domestic industry is in a position to compete effectively with other sources of pyrites or substitutes therefor. In any event, little or no use would be made of the St. Lawrence for shipments from such points of origin. In fact, taking pyrites as a whole, it is likely that their use in this country will show a relative, if not an ab-

solute, decline. We shall make our calculations on the basis of total imports of 300,000 tons per annum.

When allowance is made for the large movements to Atlantic and Pacific ports, for movements during the closed season, for the more effective competition of substitute commodities in the lake states than along our coasts, and for the influence over routing exerted by the presence of the larger importing houses along the Atlantic Coast, it would appear distinctly liberal to place the use of the St. Lawrence route for this purpose at 50,000 tons per annum. Canada appears to have no imports of pyrites.

XI. Fertilizers (Nitrates, Phosphates, and Potash)

Commercial fertilizers are one of the most important groups of commodities which it has been assumed would make extensive use of an all-water transportation route. Two of the chief raw materials, nitrate and potash, are imported from foreign countries; a third, phosphate, is mined most extensively in Florida. Opening the St. Lawrence would permit of the assembling of these commodities at Great Lakes points and it is presumed would decrease the cost of commercial fertilizers to the farmers of the Middle West. Enormous benefits for agriculture are generally anticipated.

In this analysis we shall consider the existing trade in commercial fertilizers and the principal materials which might move inbound over the St. Lawrence route. Preliminary to a consideration of traffic problems, it is necessary to define the important terms. By fertilizer is meant any substance which will add to the soil in available form nitrogen, phosphorus, or potassium, or some mixture of them.[29] Commercial or artificial fertilizer is a

[29] Available form reference to the chemical composition of a substance; that is nitrogen, potassium, and phosphorus are natural elements, like gold or oxygen, and enter into combination with a great many other elements to form a large variety of substances. Only certain ones of these compounds supply the essential elements in forms that can be assimilated by plants.

Lime is also added to the soil and furnishes a plant food but is not usually referred to as a "fertilizer" in trade usage.

trade term and refers to minerals or by-product fertilizers in contrast to manure and to cover crops which are plowed under to enrich the soil. Mixed fertilizer is also a trade term and refers to fertilizers which contain two or more of the essential elements in available form. This term is used to distinguish between mixtures of the various elements and the separate ingredients such as nitrates or phosphate rock, which are often sold separately for direct application to the soil.

For reasons which will appear later, we shall not consider the volume of traffic in fertilizer materials in relation to the St. Lawrence until after we have analyzed the character of the trade in each group of materials.

A. Analysis of Fertilizer Industry

1. *Potash.* The principal commercial source of potash has been and is today the mineral deposits in Germany and Alsace Lorraine.[30] Analysis of the traffic possibilities of imported potash as a source of tonnage for the St. Lawrence, however, is complicated by conditions in the potash industry. The cutting off of the German source of supply during the war, and the monopoly prices which have prevailed since then, have focused American attention on other potential supplies of potash salts. A large amount of experimental work has been and is being done. The mineral salts of Searles Lakes, California, and the waste dust from cement furnaces have both been successfully exploited. Both are quite well established as sources for limited amounts of potash. Mineral deposits recently discovered in Texas and New Mexico bid fair to open up an entirely satisfactory and adequate supply of potash salts to meet our entire domestic requirements. We have then to

[30] The potash fertilizer of commerce is a water-soluble salt or salts of the element of potassium. Potash fertilizers are either the crude minerals in which case soluble potassium salts are mixed with salts of other elements, or they are chemically refined or prepared soluble salts of potassium. The principal potassium salts used as fertilizers are kainite, muriate of potash, sulphate of potash, and manure salts.

consider two questions: (1) The feasibility of transporting German and French potash via the St. Lawrence, assuming we continue to import our requirements of this commodity; (2) The probabilities of domestic supplies supplanting the import trade.

Importation of potash via the St. Lawrence would be entirely feasible. An analysis of the present methods of handling potash indicates that the greater part of the imports of this commodity into the seven Middle Western states tributary to the Lakes could move via the water route. German and French potash is imported both in bulk and in bags. It moves in full cargoes to Baltimore and part cargoes to New York City. Ocean freights from the Hamburg-Havre range to North Atlantic coast ports are \$2.50 to \$3.00 a short ton.[31] Rail rates from New York, to Middle West points vary from \$6.20 to \$10.80 per ton.[32] Total freight charges from European ports of shipment to points of destination are, then, roughly \$8.70 to \$13.80 per ton.

The distances from Montreal and from New York to Hamburg are roughly the same, and vary from 3,400 to 3,700 nautical miles, according to the route navigated. The distance from Chicago to Montreal via the Lakes and River is 1,065 nautical miles; from Detroit to Montreal 510; and from Cleveland to Montreal, 458 miles.

No attempt will be made to set down a definite figure for freight rates which would be charged from trips varying from

[31] Based on quotations supplied by the Department of Commerce, for potash moving from German and Belgian ports to North Atlantic coast ports.

[32] Rail rates (per ton) from New York to Middle West points on sulphate of potash, muriate of potash, kainite, double manure salts (moving in car-load lots of 40,000 pounds, minimum weight) are given below. The rate to Des Moines, Iowa, applies for all salts except kainite which takes a rate of \$10.80 a ton.

Cleveland, Ohio	\$6.20	Milwaukee, Wis......	\$7.70
Columbus, Ohio	6.50	Chicago, Ill	7.70
Detroit, Mich.	6.50	Des Moines, Iowa....	12.40
Grand Rapids, Mich..	7.10		

1,000 to 500 miles greater than the distance from the Hamburg-Havre range to North Atlantic coast ports. Allowances of as much as 50 per cent increase in freights to Great Lakes points would give water rates of $3.75 to $4.50 to lake ports, compared with total ocean and rail rates to interior points of $8.70 to $13.80 per ton. The spread between these two ranges of rates would have to cover local freight hauls of 75 to 300 miles (rail or truck) to points of distribution, plus winter storage of the commodity, since the heaviest demand for fertilizer in this territory comes in the spring. Local rates of as much as 25 cents per 100 pounds, plus storage, would allow no margin for saving in those regions which now have a total rate as low as $8.70. For regions such as central Iowa, taking a rate as high as $13.80 per ton, a saving would seem to be assured. Since our allowance for increase in water rates above the ocean rates to North Atlantic coast ports is liberal we may assume in general that potash could move into Midwest territory at least as cheaply via the water route as it could via present channels of distribution, and probably at a saving of $3.00 or $4.00 per ton to some regions. In estimating the significance of this potential saving in freight rates, however, the relatively small amount of potash in a ton of mixed fertilizer must be borne in mind. (See discussion on page 538.)

Potential domestic sources of potash make estimates of import tonnage of German and French potash of uncertain value. Knowledge of the Texas and New Mexico potash deposits is too limited at the present time to make any forecasts as to the future of this field. Sufficient information is at hand, however, to make the future of our international trade in potash an open question. The Department of Commerce in surveying the situation makes the following statement:

. . . The exploratory work of the United States Geological Survey indicates that in western Texas and probably in the southeastern part of New Mexico there are vast beds of potash salts within 1,200 feet of the surface and extending through wide areas. Some of the drillings show large percentages of potash, and it is

quite certain, the geologists state, that in this region the nation possesses enormous reserves of potash.

It may be noted further that the better grades of rock obtained from this Texas-New Mexico district are comparable in richness to the crude salts of the German and Alsace mines; that the potash salts are water-soluble and are found associated with material which would be neutral or beneficial in the making up of a commercial fertilizer.

Estimating costs at which these deposits might be worked and the probable effect of exploitation of these mines on prices obtained for German potash is a problem entirely beyond the scope of this present study. In making our estimate of traffic for St. Lawrence we shall include potash. The present status of our domestic potash situation has been given briefly to indicate the conditions upon which such an estimate must be accepted.

2. *Phosphate.* Commercial sources of phosphates for use as fertilizer are basic slag from blast furnaces, bone meal, and certain phosphatic minerals known as phosphate rock.[33] Basic slag is produced and used in Europe.[34] Bone products are prepared by packing and rendering establishments. In terms of volume, however, neither of these sources is important in the United States. Hence, we shall confine our analysis to the products derived from phosphate rock as sources of potential traffic for the St. Lawrence.

The production of phosphate fertilizers involves the control of two raw materials—phosphate rock and sulphuric acid. The products manufactured are superphosphate, which con-

[33] The essential element with which we start in this industry is phosphorus. The available plant food which must be supplied to the soil is phosphoric acid. Commercial phosphatic fertilizers are relatively unstable salts of phosphoric acid which may be handled in a dry form but which dissolve readily when brought in contact with the moisture in the soil.

[34] Basic slag is a by-product obtained in the manufacture of steel from phosphatic pig iron by the basic Bessemer process. This process is not used in the United States.

tains 14 to 20 per cent of available phosphorus, and treble superphosphate, which contains 40 to 50 per cent of available phosphorus.[35] The raw phosphate rock, as mined, is also applied directly to the soil as a fertilizer.

The present commercial sources of phosphate rock are open-pit mines in Florida, Tennessee, and Idaho, and some underground mines in Tennessee. The sulphuric acid which enters into the production of superphosphate is manufactured directly from various raw materials such as free sulphur, iron pyrites, and copper pyrites, or it is obtained as a by-product from the copper and the zinc smelting industries, depending upon the location of the superphosphate factory.

The fertilizer companies which have facilities for treating phosphate rock with acid are classified as " wet mixers." The plants which treat the rock with acid are referred to as acidulating plants.[36] Fertilizer companies who buy all their materials, potash, ammoniates, and superphosphate already prepared for mixing are called " dry mixers."

We are now ready to consider the feasibility of shipping phosphates into Great Lakes territory via the St. Lawrence. There are three developments which might take place:

[35] Superphosphate is the ordinary product of commerce. It is a mixture of the active fertilizer material " available superphosphate " and gypsum—the other product formed when the sulphuric acid and phosphate rock are brought together.

Treble superphosphate (or as it was formerly called double superphosphate) is a concentrated product. It may be considered as superphosphate with the gypsum removed.

See Dictionary of fertilizer terms, *Fertilizer Handbook*.

" Treble superphosphate " is prepared principally by the Anaconda Copper Co.

[36] Rock phosphate moves to acid rather than vice versa because of the difficulties involved in handling and shipping sulphuric acid. If by-product acid is not available in regions where it is required, sulphuric acid plants are built and either sulphur or pyrites are shipped in for its manufacture. With the exception of the war period, 200 miles has been the maximum haulage for acid in the Eastern part of the United States.

(1) Fertilizer companies having acidulating plants in the Great Lakes region—the wet mixers—might bring in their year's requirements of phosphate rock from Florida, via the St. Lawrence.

(2) Dry mixing plants located in Great Lakes territory might purchase superphosphate from acidulating plants located on the Atlantic seaboard, shipping it over the St. Lawrence route.

(3) Dealers, retail merchants, and farmers' coöperative stores located in territory tributary to the Great Lakes might import Florida phosphate rock for sale direct to farmers for direct application to the soil.

a. *Wet mixers* are located in Illinois, Ohio, and Indiana. There is one plant in Detroit but no other in the State of Michigan, and none in Iowa or Wisconsin. For the purpose of studying freight charges on their phosphate rock supplies, the wet mixers may be divided into three groups; those located in lake cities (including Canton, 60 miles from Cleveland); those located on the Ohio river (including in this group East St. Louis); and those located at points intermediate between the Ohio river plants and the plants at lake ports. As the plant and equipment used for treating rock with acid are referred to as acidulating plants we are using that term in the classification given below, and in the discussion which follows.

CITIES IN GREAT LAKES AREA HAVING ACIDULATING PLANTS

Lake Points	Ohio River [a] Points	Intermediate Points
Cleveland	Cincinnati	Columbus
Canton		Dayton
Sandusky		Washington C. H., Ohio
Toledo	New Albany, Ind.	Fort Wayne
Chicago	Seymour, Ind.	Indianapolis
Chicago Heights		
Hammond, Ind		
Detroit		

[a] East St. Louis is included in this group.

The sources of phosphate rock used in each of these regions were obtained from a questionnaire which was sent to the acidulating plants. Some of the plants located at Toledo and Cleveland use Florida rock, bringing it in via ocean freighters and the canal barges on the New York State Canal. A plant located at New Albany, Indiana, uses Florida rock, shipping it all rail; otherwise the acidulating plants in this region use Tennessee rock. All of them agree that freight rates are the determining factor in their source of supply. A number indicated their preference for Florida phosphate rock and were much interested in the possibility of rates, via the St. Lawrence, low enough to permit them to use Florida rock.[37] Our problem, then, is to compare potential rates on Florida rock via the St. Lawrence with the cost of bringing rock into these three districts via existing transportation routes.

Ohio River points. It would not be feasible to ship Florida phosphate rock via the St. Lawrence route to lake points and thence inland to acidulating plants on the Ohio River. A comparison of freight rates shows that it costs as much to transport Florida rock to Baltimore in ocean vessels as it does to transport Tennessee rock all rail to Seymour, Indiana, or to Cincinnati. From Mt. Pleasant, Tennessee, to Seymour the rail rate on phosphate rock in carlots is \$3.17 per short ton: to Cincinnati it is \$3.12. The cost of moving Florida rock from the mines which are in the center of the state, to Tampa (including delivery aboard steamer) is \$1 per short ton; the average ocean freight on Florida rock, Tampa to Baltimore, may be taken as \$1.78 per short ton, making a total of \$2.78 on rock moving from Florida mines to the port of Baltimore. A cost of 25 cents per ton for transferring the rock from ocean steamer to a railway car would therefore make the total cost of Florida rock, delivered at Baltimore, as high as the rail rate on Tennessee rock delivered to acidulating plants on the

[37] For a discussion of Idaho phosphate rock and treble superphosphate, see pp. 537-38.

Ohio.[38] Clearly then there would be no opportunity for superphosphate manufacturers, located as far inland as the Ohio River, to save freight costs on their phosphate rock requirements by using the St. Lawrence.

Lake cities. Acidulating plants located at Erie ports possibly could ship in Florida rock via the St. Lawrence route. The rail rate on phosphate rock in carlots, Mt. Pleasant, Tennessee, to Toledo is $4.50 per short ton; to Cleveland $4.66. The all-rail rate on Florida rock in carlots Bartow, Florida, to Toledo is $7.50 per short ton; to Cleveland $7.70. We are not able to obtain satisfactory data on the cost of shipping Florida rock to Cleveland and Toledo via coastwise vessels and Erie barges. The Munson Steamship Line operates both coastwise vessels and canal barges and they undoubtedly make their joint rates low enough for rock moving in their vessels to meet the competition of Tennessee rock moving all-rail. Since, however, the Florida rock is preferred to the Tennessee rock we cannot assume that Florida rock is delivered at Cleveland and Toledo at exactly the same rates as Tennessee rock.[39] And, lacking data on the exact cost of shipping Florida rock to Erie ports via coastwise vessels and canal barges we have no specific rate with which to compare potential rates via the St. Lawrence. If, however, we assume that coastwise vessels could get as favorable a balance of cargoes between Great Lakes points and Tampa as they can between North Atlantic ports and Tampa, we get a rate of about $3.56 per short ton as the charge which would be made for transporting Florida rock from Tampa to a

[38] East St. Louis, Illinois, takes a rate of $3.41 per short ton on Tennessee rock. As this point is further from a lake port than Cincinnati, the data given above make it evident that acidulating plants located here could not handle Florida phosphate rock via the St. Lawrence.

[39] There is a consensus of opinion among writers on the fertilizer industry that Florida rock has a lower production cost and is of a better quality than the Tennessee rock. We were not able, however, to obtain from the fertilizer industry any information as to how much of a differential in freight rates the Florida rock can bear because of these factors.

Lake Erie port.[40] Adding to $3.56 per ton, another $1.00 to cover the cost of transporting the rock from Florida mines to Tampa and loading it into the steamer, we have an estimate of $4.56 as the probable cost of shipping phosphate rock to Lake Erie ports via the St. Lawrence. While a charge of $4.56 per ton is roughly equivalent to the rail rate on Tennessee rock to these points and would obviously afford no great saving in freight charges to manufacturers of superphosphate located at lake ports, we shall give the water route the benefit of the doubt and assume that some Florida rock would move into lake ports were the St. Lawrence available.

Intermediate points. It seems quite improbable that acidulating plants any distance inland from Lake Erie ports could handle phosphate rock via the St. Lawrence at a saving in freight rates. As representative of the intermediate territory we may consider acidulating plants located at Columbus and Indianapolis. Manufacturers of superphosphate at Columbus pay a rail rate of $4.13 per short ton on carlot shipments of Tennessee rock; manufacturers at Indianapolis pay $3.71 per ton on Tennessee rock.

If then, we compare Columbus with Cleveland we note that the rail rate on Tennessee rock to Columbus is 53 cents lower than it is to Cleveland, and that Columbus is 138 miles inland from Cleveland. An allowance as low as 50 cents per ton for the inland haul (rail or motor truck), and 25 cents per ton for the extra handling would mean that rates on Florida rock would have to be only $2.85 to Cleveland if this rock were to be put down in Columbus at the same cost as Tennessee rock.

Since we have already shown that rates on phosphate rock from Florida mines to Lake Erie ports via the St. Lawrence would have to be approximately $4.50 per short ton, a movement of Florida rock inland clearly would not be feasible.

[40] From Tampa to Baltimore by water is 1,469 statute miles; from Tampa to Cleveland via the proposed St. Lawrence route would be 3,628 statute miles.

As Indianapolis enjoys a lower rate on Tennessee rock than Columbus does, and is still further inland from a lake port than Columbus, it follows that we need not further discuss rates on phosphate rock to inland points.

b. *Dry mixers*, as has been indicated, are firms engaged in manipulating two or more of the prepared materials. They may be branch establishments representing the large fertilizer companies, or they may be independent concerns. In either case, the function of a dry mixing plant consists in the screening and mixing of ammoniates, superphosphate and potash, according to standard formulæ or to meet specific requirements. The locations of the dry mixing plants are determined by the market for fertilizers. Their success is dependent primarily on their contact with the farmers, either direct or through dealers. Reliability, handling of a well established brand of goods, ability to extend credit, railway connections for prompt delivery of bag or carload business are the trading assets of the dry mixers.

This branch of the fertilizer industry might possibly bring in occasional shipments of superphosphate via the St. Lawrence. It is conceivable that both the large fertilizer manufacturers and the small independents might occasionally use the water route. If the large fertilizer corporations found themselves with surplus stocks of superphosphate along the Atlantic seaboard, at a time when the demand in Great Lakes territory was greater than had been anticipated, they might find it advantageous to ship some superphosphate from their Atlantic coast plants to lake ports for distribution in the Middle West. Likewise the small independent dry mixers, located in Great Lakes territory, particularly dry mixers located in Iowa, Wisconsin, and Minnesota, might purchase superphosphate occasionally from the producers located along the Atlantic coast rather than buy from the acidulating plants located in Illinois, Indiana, and Ohio. It seems quite clear, however, that no volume of traffic in superphosphate could be expected to move over the St. Lawrence route. All that can be said is, that it is

at least possible that superphosphate would furnish occasional traffic when there was a temporary lack of equilibrium between Eastern and Western markets for prepared fertilizers, and when shipping accommodations happen to be available at the time needed.

c. *Dealers.* Florida phosphate rock might be shipped into Great Lakes ports to supply the local demand for raw rock as a fertilizer. So far as sources of supply are concerned the position of dealers and farmers' coöperatives interested in phosphate rock would be identical with that of the wet mixers. As we have shown the possibilities of shipping Florida rock into Great Lakes territory in competition with Tennessee rock would be limited to Great Lakes ports and their immediate environs, it follows the territory which might possibly use Florida rock directly would likewise be limited to farm regions contiguous to lake ports.

3. *Nitrogen.* In this section our interest will be centered in nitrogen compounds, particularly Chilean nitrate of soda, as sources of potential traffic for the St. Lawrence. The character of the nitrogen industry, however, is such that we cannot discuss Chilean nitrate except as one of the group of nitrogenous raw materials.[41] Hence we shall give our attention first

[41] The terminology pertaining to this group of materials cannot be adequately explained in a study of this length. The following definitions are sufficiently inclusive to meet the requirements of a traffic analysis:

Nitrogen. The primary meaning of this word is the chemical element nitrogen, a very inert gas which makes up four-fifths of the atmosphere. With the exception of the leguminous plants such as clover and alfalfa, neither animal nor plant life can use nitrogen in this form. In this study we do not use the word in this chemical sense except in connection with the fixed nitrogen industries. See note below.

Nitrogen industry, nitrogenous products. As these terms are used in this study they refer to the materials which contain nitrogen in such forms that it can be assimilated by plants.

Fixed nitrogen. This term refers to the synthetic nitrogen compounds. It is used because the chemical element nitrogen is made to combine with other chemical elements to form substances which otherwise would have to be obtained from nature.

to some general information relative to the organization of the nitrogen industry as a whole.

a. *Sources of nitrogen.* The principal industries which compete for the supply of nitrogen compounds are the fertilizer, explosive, and basic chemical industries, the by-product stock feed industry, and the refrigerating trade. The commercial sources of nitrogenous products are the sodium nitrate deposits in Chile, ammonium sulphate derived from the by-product coke industry, the synthetic compounds (the fixed nitrogen branch of the industry), cottonseed meal, packing-house tankage and blood, and various other animal and vegetable waste products. Something of the significance of each source of raw material may be indicated.

Chilean nitrate.[42] The natural deposits of sodium nitrate in northern Chile are enormous; they could readily supply the world's entire nitrogen requirements for many years to come. The quantities of nitrates mined annually are determined by the general level of prices for nitrogenous products.

By-product ammonium sulphate. The amounts of this material produced are governed primarily by the market for coke and secondarily by the market for ammonia. The sequence of processes is as follows: when coal is distilled to produce coke it gives off a mixture of illuminating gas and ammonia. To make the illuminating gas saleable it must be freed of the ammonia. Separation of the two gases is accomplished by running the mixture through water or through a solution of sulphuric acid. In the first case, illuminating gas and ammonium liquor

[42] There are three general classes of materials of interest to the fertilizer trade as sources of nitrogen.

1. *Nitrates.* These consist of combinations of nitrogen and oxygen combined with some metallic material such as soda, potash, or lime.

2. *Ammonia salts.* In these compounds the nitrogen is combined with hydrogen to form ammonia, and the ammonia is combined with some acid, as sulphuric or nitric.

3. *Organic nitrogenous material.* In these materials the nitrogen is combined with complex organic compounds.

(ammonia gas dissolved in water) are obtained. In the second case, illuminating gas and ammonium sulphate (a white powder) are obtained.

Coke is used principally for blast furnace operations; hence the amount of coke produced is governed by the activity of the steel industry. The amount of ammonia sold in the form of ammonium liquor is determined by the market for ammonia. The refrigerating trade and the manufacturers of basic chemicals are the principle industries which supply a market for nitrogen in the form of ammonia. Ammonia which cannot be sold to these industries is converted into sulphate and sold to the fertilizer trade.[43]

Synthetic compounds. In contrast to Chilean nitrate which is a natural resource and ammonium sulphate which is a by-product, the synthetic nitrogen compounds are manufactured products. These manufactured products have injected a large degree of uncertainty into the future of the entire nitrogen industry. Their present development has been attained largely as a result of the demand of European and American nations for self-sufficiency in nitrogen resources, as measures of national defense. What their future will be, whether they will supply but a limited part of the demand for nitrogen or will tend to displace the Chilean source of supply, is a problem beyond the scope of this study.[44]

Cottonseed meal and packing-house by-products. The sources of these products require no comment. The bulk of

[43] The nitrogen compound of interest to industry is the gas ammonia, but it is obvious that no chemical will be handled in the form of a gas if it can readily be utilized as a liquid and that it will not be handled as a liquid if it can be conveniently used as a solid.

[44] It will occur to the reader that estimating the costs of production for Chilean nitrate and for ammonium sulphate are difficult problems. It is also difficult to forecast the trend of costs for synthetic nitrogen compounds. The most important items of cost for manufacturing synthetic ammonia are the cost of hydrogen and the cost of power. When nitrogen is fixed in the form of nitric acid, the cost of oxygen and the cost of power are the most important factors determining the cost of the product.

the tonnage goes into stock feed. Inferior grades of these products constituting some 10 to 15 per cent of the tonnage go into the fertilizer trade, the quantity being used for this purpose in any one year being determined by the general level of prices for stock feeds on the one hand and for nitrogenous fertilizers on the other.

Animal and organic waste products. This group of materials includes garbage, sewage, fish scrap, factory refuse, etc. The quantities of these materials which are disposed of as fertilizers, are determined partly by considerations of the cost of preparing them—in relation to prices of other nitrogenous fertilizers—and partly by considerations of public health. With the increasing density of population there is more and more need for the handling of sewage and refuse in such a way as to avoid contaminating the water supply.

b. *Demand and supply.* We have before us the sources of nitrogen compounds. As a second step in our analysis it is essential that we have in mind the competitive position of these materials in relation to the total demand for nitrogen. The market situation as it exists at the present time may be described as follows.

In terms of quantities marketed, Chilean nitrate and ammonium sulphate are by far the most important nitrogenous materials. They may be considered the staples of the industry. In terms of aggregate tonnage of all classes of nitrogen materials, the fertilizer trade is the consuming industry of primary importance.

The manufacturers of explosives create a market for Chilean nitrate of a relatively high degree of purity. Apart from this special demand Chilean nitrate must be sold to the fertilizer trade.

The manufacturers of synthetic nitrogen compounds and the producers of by-product ammonia compete in supplying the refrigerating trade and the basic chemical industries with their requirements. Apart from these markets, synthetic products must be sold to the fertilizer trade.

Packing-house by-products and cottonseed meal, which enter into the fertilizer trade, may be thought of as specialties, since they are more often sold for direct application to the soil rather than for use in the manufacture of mixed fertilizers.

c. *The nitrogen traffic problem.* With this general survey of the nitrogen industry in mind we may turn to the consideration of transportation problems. Two questions need to be considered. First, would Chilean nitrate move into Great Lakes territory via the St. Lawrence route in competition with the existing sources of nitrogen? Second, would by-product and synthetic nitrogen compounds be imported into these regions from Europe?

In analyzing these questions pertaining to traffic we shall depart from our usual procedure and state our conclusions first, following them up by supporting data. We do this because answers to these questions must be based on a bird's eye view of all the factors involved. Our principal findings, then, may be summarized as follows.

(1) It would not be practicable for the fertilizer industry to ship large quantities of Chilean nitrate into the Middle West via the St. Lawrence route. The territory tributary to the Great Lakes is a surplus production area having an output of ammonium sulphate (including the western Pennsylvania output of by-product nitrogen) equivalent to four and two-thirds times its present nitrogen requirements for mixed fertilizers. The Southern states import annually some nine-tenths of their nitrogen requirements, equivalent to 577,000 tons of Chilean nitrate. The distance from Iquique, Chile, to Chicago via the all-water route is 7,620 miles. The distance from Iquique, Chile, to New Orleans is 3,953 miles. There could, therefore, be no national economy in shipping Chilean nitrate 3,500 miles past an area of deficit production into an area which has a surplus output of by-product nitrogen.

(2) Domestic plants which have been built thus far for the manufacture of synthetic nitrogen compounds are located favorably to Great Lakes territory. Assuming that they expand

their output of synthetic nitrogen sufficiently to become a real factor in the fertilizer trade they still would not use the St. Lawrence route to supply the trade of the Middle West.

(3) It is to be expected that our coastal regions will continue to be the primary markets for any miscellaneous nitrogen compounds which the fertilizer trade imports from Europe, South America, and other foreign countries.

The supporting data for the above conclusions may be developed briefly.

The five states, Ohio, Illinois, Indiana, Michigan, and Wisconsin for the year 1927 consumed in the form of mixed fertilizers 16,248 tons of nitrogen; Minnesota, North Dakota, South Dakota, Nebraska, and Iowa for the same year consumed a total of 375 tons of nitrogen in mixed fertilizers. The 1927 output of by-product ammonium sulphate in these ten states was 211,929 tons, equivalent to 43,657 tons of nitrogen. The output of by-product ammonia and ammonium sulphate in the western half of Pennsylvania was equivalent to 34,173 tons of nitrogen. Adding the actual production of nitrogen in ammonium sulphate in lake states to this nitrogen output of western Pennsylvania we have a total of some 78,000 tons—four and two-thirds times the nitrogen requirements for the mixed fertilizers used in Great Lakes territory at the present time.

The sources of ammonium sulphate are well located with reference to the heaviest demand for fertilizer. The states of Ohio, Indiana, and Michigan are the heaviest consumers of mixed fertilizer, accounting for 80 per cent of the total tonnage sold in 1927 in the ten states listed above. The states of Ohio, Illinois, and Indiana produced over 90 per cent of the total output of ammonium sulphate for the ten consuming states listed above.

During the year 1927 the Southern states consumed 91,112 tons of nitrogen in the form of mixed fertilizer. The output of by-product ammonia and ammonium sulphate in Alabama

(the only Southern state which manufactures coke and by-products in any quantity) for that year was equivalent to only 1,541 tons of nitrogen. This left a deficit of 89,571 tons of nitrogen (equivalent to 577,000 tons of nitrate) to be supplied by Chilean nitrate and other sources of supply.

No data are available to show the amounts of synthetic nitrogen compounds produced in the United States at the

United States Producers of Synthetic Nitrogen Compounds

Operator	Location	Capacity Tons Nitrogen
Atmospheric Nitrogen Co.	Syracuse, N. Y.	10,000
	Hopewell, Va.	....
Mathieson Alkali Co.	Niagara Falls, N. Y.	4,000
Pacific Nitrogen Corp.	Seattle, Wash.	865
Lazote, Inc.	Belle, W. Va.	9,000
Roessler and Hasslacher Co.	Niagara Falls, N. Y.	865
Great Western Electro-Chemical Co.	Pittsburg, Calif.	300
Total		25,030 [a]

[a] 25,030 tons of nitrogen would be equivalent to approximately 161,000 tons of Chilean nitrate.

present time. It is the opinion of the trade that the domestic output of these products thus far has gone into the refrigeration, explosive, and chemical trades.[45] The producers of synthetic nitrogen are listed in the table above.

It will be seen that none of the synthetic nitrogen plants is so located that it could make use of the St. Lawrence to supply our domestic markets. The Niagara plants might, however, ship nitrogen compounds outbound via the deep waterway.

[45] See Bates, H. R., "Economic Relationships Between Nitrogen and Fertilizers," in *Industrial and Engineering Chemistry,* November, 1928.

The United States imports by-product ammonium sulphate and synthetic nitrogen compounds from Europe; and some miscellaneous materials from other sources, such as tankage and dried blood from Argentina. These materials are utilized in part by the chemical trades and in part by the fertilizer in-

UNITED STATES IMPORTS OF CERTAIN NITROGENOUS MATERIALS [a]

Material	Average Imports 1925-1927 (Long tons)	Percentage [b] of Nitrogen	Nitrogen Content (Long tons)
Calcium nitrate	13,176	15.5	2,042
Cyanamid (fertilizer) [c]	65,945	20.6	13,585
Leuna saltpeter	44,659	26.0	11,611
Sulphate of ammonia	16,437	20.6	3,386
Tankage	26,100	7.4	1,931
Dried blood	11,198	13.0	1,456
Other nitrogenous material	66,050	7.4	4,888
Total			38,899

[a] Figures for imports obtained from *Foreign Commerce and Navigation*, except for fertilizer cyanamid. Such materials as guano and Ammo-Phos were omitted from the table because they contain two or more fertilizer elements.

[b] Estimates of nitrogen content obtained from article of Mr. Bates previously referred to.

[c] Nearly all the crude cyanamid imported into this country comes from a Canadian plant at Niagara Falls. This material is used principally for the manufacture of fertilizer cyanamid and Ammo-Phos. The figure for fertilizer cyanamid is the average three-year output of this product as reported by the American Cyanamid Company (Moody *Manual of Investments*, 1928).

dustry. In the table above we have set down an estimate of the classes and quantities of these materials which entered into the fertilizer trade in 1925-1927, together with an estimate of the amounts of nitrogen they contain.

From the accompanying table it will be seen that exclusive of the 13,500 tons of cyanamid which comes across the border at Niagara Falls we import annually minor nitrogenous ma-

terials having a nitrogen content of something like 25,000 tons. Twenty-five thousand long tons of nitrogen is less than 15 per cent of our total nitrogen requirements for fertilizer purposes. Taking into account the fact that the markets for these materials are largely restricted to our coasts at the present time and the further fact that the Middle West is an area of surplus production for nitrogenous materials in general we conclude that this class of products would not be a potential source of traffic for a deep waterway.

B. Estimate of Fertilizer Traffic

We are now ready to estimate the quantities of fertilizer materials which might be transported over the St. Lawrence route. Average sales of fertilizer materials for the years 1925-1927 in Great Lakes states are shown in the following table:[46]

	Short tons
Ohio	313,047
Indiana	231,642
Illinois	25,838
Michigan	112,218
Wisconsin	17,006
Minnesota	7,666
Iowa	6,393
Total	713,810

If we double the estimated present consumption of fertilizer in these states to allow for a greater use of fertilizer in these states, we have a figure of 1,500,000 tons on which to base a traffic estimate. The quantities of the three materials—nitrogen, phosphate, and potash—which enter into 1,500,000 tons of fertilizer would be determined by the grades of fertilizers used. For the purpose of this analysis we may assume that the 1,500,000 tons would be made up of 146,000 tons of ammonium sulphate or 192,000 tons of nitrate, 200,000 tons

[46] Compiled from *Fertilizer Handbook.*

of potash, and 1,125,000 tons of superphosphate (requiring approximately 562,250 tons of phosphate rock).[47]

(1) In line with our analysis of potash we shall set down all of the 200,000 tons of potash imports as potential traffic for the waterway.

(2) With reference to phosphate, we shall assume that all of the Michigan requirements and half of the Ohio requirements might utilize the water route; on this basis we may set down 215,000 tons of phosphate rock as potential inbound traffic.

(3) Having shown in our analysis of the nitrogen group that the Great Lakes states are a region of surplus production for these products, there is no reason for forecasting any considerable inbound movement of nitrogen compounds via the St. Lawrence. There would, however, be some demand for Chilean nitrate to supply the requirements of those who prefer that product. To meet this requirement we shall assume that as much as 20,000 tons of Chilean nitrate would be imported annually via the St. Lawrence route.

Since the Great Lakes region is an area of surplus production for ammonium sulphate there would no doubt be some opportunities for shipping this product outbound over the St. Lawrence to fertilizer manufacturers located along the North Atlantic coast. It has not, however, seemed feasible to study in detail the market possibilities for this product in every coast

[47] Work is carried on by State Agricultural Experiment Stations to determine the relative amounts of the various elements which will give best results with given soils and given crops. Commercial fertilizers are mixed on the basis of results obtained by these stations, and are identified by trade formulæ. For the purpose of making a general estimate for Great Lakes territory the National Fertilizer Association has suggested that we use a "2-12-4" fertilizer, that is, a mixture containing 2 per cent of nitrogen, 12 per cent of superphosphate and 4 per cent of potash.

In computing the figures given above, we have used 16 per cent superphosphate, and have assumed that potash salts imported at Great Lakes ports would be imported in roughly the same relative amounts as they are at the present time.

port. We shall, therefore, allow 50,000 tons of ammonium sulphate as potential outbound traffic for the St. Lawrence.

Canada imports at the present time 13,000 tons of potash, 26,000 tons of sodium nitrate, and 64,000 tons of superphosphate annually.[48] The sources of these materials will be recalled by the reader from our previous analysis. The nitrate comes from Chile, the potash from Europe, and the superphosphate from the United States and Europe.

No data are at hand to show the distribution of these imports according to the geographic regions in which they are used. For the purposes of this analysis, we may assume that as much as a third of Canada's imports of fertilizer material could use the St. Lawrence route. In line with our estimates for the United States we shall also allow for a 100 per cent increase in Canada's requirements of commercial fertilizers by the year 1940. On the basis of these assumptions we shall set down as a very rough estimate of Canadian traffic the following: imports of potash, 10,000 tons; imports of Chilean nitrate, 20,000 tons; and imports of superphosphate, 40,000 tons.

The estimates given above of fertilizer traffic are used as a part of our total traffic estimate for the United States and Canada. In connection with our analysis, however, it is desirable to call attention to factors bearing on the future equilibrium of the fertilizer industry which we have not been able to evaluate.

Attention has already been called to the possibility of exploiting domestic potash deposits. Such a development might change materially our position as an importing nation of potash.

Idaho treble superphosphate is a potential competitor of Florida and Tennessee sources of superphosphate. The Anaconda Copper Company is producing a superphosphate at Anaconda, Montana, utilizing Idaho phosphate rock and by-product sulphuric acid. This product, treble superphosphate,

[48] Three-year average imports 1925-27.

is a concentrated material containing 48 per cent of available phosphoric acid, compared with 16 per cent available phosphoric acid in ordinary superphosphate. The Montana product is now being sold as far east as Michigan and Indiana. We were not able however to obtain from the Anaconda Company, or from other sources, any information as to the volume of this product now being sold in Great Lakes territory. Nor did we obtain any information as to the potential future markets for treble superphosphate in the Middle West. This unknown factor in the phosphate trade might upset any calculations we have made on the potential markets for Florida and Tennessee rock.

It is a fair statement to say that no reliable forecast can be made as to the future of American and European synthetic nitrogen compounds. Technical improvements resulting in lower production costs either for American producers or for European, together with tariff legislation may bring about a new equilibrium in the whole nitrogen industry at any time.

Finally, it must be borne in mind that any calculations made on the basis of the present consumption of fertilizers may be upset by the increased use of more concentrated materials. A ton of 2-12-4 fertilizer, for example, contains only 18 per cent of material which is actually of value to plants; the other 82 per cent is filler. It is theoretically possible, therefore, to cut down materially the volume of fertilizer materials handled by our transportation agencies by greatly increasing the concentration of the chemical salts which enter into a ton of fertilizer and by changing the practices of the industry so as to prepare mixed fertilizers either at the farm or much nearer the farm than is now the practice. How far changes along these lines will take place and how rapidly is, of course, a subject which we cannot enter into in a traffic analysis. It is clear, however, that changes along the lines indicated might affect materially the volume of fertilizer which would move over the St. Lawrence route.

XII. Cement and Gypsum

1. *Cement.* Owing to the wide distribution of raw materials suitable for the manufacture of cement, rail movements of this product ordinarily take place within a 200-mile radius of the producing plants. On the Great Lakes 350 miles appears to represent the usual maximum length of haul. The following statistics of production in thousands of barrels for 1927 show the wide distribution of output:

	Barrels		Barrels
Alabama	7,565	Ohio	8,854
California	14,581	Pennsylvania	43,732
Illinois	7,017	Tennessee	4,431
Iowa	5,415	Texas	5,656
Kansas	6,180	Other[49]	38,257
Michigan	13,965		
Missouri	6,778	Total	173,206
New York	10,775		

Only 16,000 tons of cement moved in the intercoastal trade in 1927-28, most of which went west from Baltimore, Philadelphia, and Newark. It is conceivable that a little cement would move between the Lakes and the coasts at very low rates, but such movements would be small and irregular and scarcely entitled to weight in a traffic analysis.

Our imports of cement, though but a small fraction of the domestic production, have shown a large increase in the last few years, as the following figures indicate:

	Barrels
1920	524,604
1921	122,322
1922	355,931
1923	1,767,264
1924	2,023,663
1925	3,667,458
1926	3,244,223
1927	2,065,730

[49] The states included in the "Other" group are Colorado, Florida, Georgia, Indiana, Kentucky, Louisiana, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oklahoma, Oregon, South Dakota, Utah, Virginia, Washington, West Virginia, and Wisconsin.

This cement comes mainly from Belgium, the Scandinavian countries, and to some extent from England. It is enabled to move in competition with domestic cement owing to the very low ocean transportation rates it obtains as back loading for vessels carrying our products to Europe. Relatively little comes in at New York. The New England ports, Philadelphia, Gulf and Pacific ports as would be expected are the important points of entry, rather than New York.

Indications are that little of this cement could find a profitable market in the lake states. The difference between conditions here and on our coasts comes largely from the fact that most of the important lake cities have plants in their very midst or near at hand. There is a large plant at Montreal, two plants are building at Buffalo, and there are plants at Fairport, Castalia, Bay Ridge, and Toledo, Ohio; Detroit, Alpena and Petoskey, Michigan; Manitowoc, Wisconsin; Buffington, Indiana; and Duluth, Minnesota. It must also be borne in mind that boats coming in light would in most instances move to Duluth, Fort William, and Chicago for out loadings of grain. Of these cities only the last is a large market for cement. While it would be rash to predict that no cement would come in as back loading from Europe, it is practically impossible to predict the extent of such a movement. The fact that this would be distress traffic moving into the heart of extensive domestic production makes the inclusion of such an item in our final traffic estimates the less necessary.

Canada's imports are of declining importance and, in so far as they do not originate in the United States, are subject to the limitations indicated above.

Our exports of cement have been as follows in recent years:

	Barrels		Barrels
1920	2,985,807	1924	878,543
1921	1,181,014	1925	1,019,597
1922	1,127,845	1926	974,326
1923	1,001,688	1927	816,726

Latin America is by far our best market, taking nine-tenths or more of our exports. Cuba and Mexico are particularly important. Canada, Europe, and the Far East take relatively little. New York accounts for seven- to eight-tenths of the exports. Florida and other Southern ports handle a good deal, and the Pacific ports are largely used. What chance would interior cement have of moving in export in competition with shipments from these points?

Certain considerations at once stand out. The first is the roundaboutness of the St. Lawrence route for trade with our most important market—Latin America. The second is the importance of frequency of vessel service, in which New York would continue to be the most favored port on the American continent. Third, shipments to the Far East are likely to originate in large part on our West Coast, owing to the frequency and regularity of vessel sailings from there, while shipments to Mexico and Cuba are likely to continue to move in considerable part all-rail (to Cuba by car-ferry from Key West). Fourth, the interior companies are likely to allow the relatively unimportant export trade to go to concerns (perhaps companies affiliated with those in the lake states) more favorably situated for developing the export market. Fifth, there is the seasonal closing of the St. Lawrence route as a special deterrent against the lake companies reaching into foreign markets.

The considerations named have all been adverse in character and yet it is possible that a little cement would move from the Lakes in export. Boats needing all the traffic they can get might pick up irregular shipments of cement at low rates. Liberally estimated, it is doubtful whether such shipments could exceed 105,000 barrels per annum, or roughly 20,000 tons.

Canada's exports of cement go in large part to the United States, her exports to other countries averaging 32,000 tons in 1925-1927. Some moves to Newfoundland and Labrador, but there are movements to the Caribbean region also. Production in Canada is largely in Quebec and Ontario, with the prairie

provinces and particularly British Columbia becoming of greater importance. In view of the large movement from Montreal today, which could not be attributed to the St. Lawrence waterway, an estimate of 10,000 tons of export traffic in cement seems distinctly liberal.[50]

2. *Gypsum*. Crude gypsum is used in the manufacture of Portland cement and as a fertilizer; after calcining, it is used in the manufacture of plaster, plaster boards, etc.[51] Gypsum is mined in western New York, Virginia, Ohio, Michigan, and Iowa, and in all but eight of the states west of the Mississippi. Canada also has widespread resources of gypsum, but only those in Nova Scotia, New Brunswick, and Ontario interest us much here. The Nova Scotia and New Brunswick product moves in considerable volume by water to Atlantic coast points, particularly New York, but apparently little other Canadian gypsum enters the United States.

It does not appear likely that the deepening of the St. Lawrence would work any appreciable change in the present situation. Wide distribution of supplies and the low value of gypsum largely account for this conclusion. Our own production in New York and the Middle West is ample to meet the needs of that general section, while on the other hand there would be little or no opportunity to move this interior gypsum to the Atlantic coast via the St. Lawrence, with American and Canadian supplies nearer at hand. The large companies have plants in most of the regions where gypsum is now mined, while the small companies work local deposits and do a more or less local business. The only possibility is that some Nova Scotia gypsum would find its way into the lake states because of a superior quality—the production of a white finish—which it, the Kansas

[50] This represents a relatively larger part of the Canadian exports than the figure hitherto given does of the United States exports, owing to the fact that Canada would have fewer options than the United States to use plants not adjacent to the waterway.

[51] Much of the information used is from Spurr and Wormser, *The Marketing of Metals and Minerals*, 1925.

and the Oklahoma gypsum, alone possess. But the demand for this particular quality in gypsum is limited.

Canada exports no gypsum to countries other than the United States and she imports no gypsum.

Our exports of gypsum and manufactures of gypsum averaged 18,000 tons in 1925-1927. New Zealand, Canada, Cuba, and the Philippine Islands are our best markets; little is sent to Europe. About one-half of the total passes out through Pacific ports, as would be expected, with New York and the Gulf ports also important. When account is taken of the disadvantages of using the roundabout St. Lawrence route, with infrequent service available during only about six months of the year, it appears reasonable to expect that existing transportation routes would continue to be used in reaching these outlying markets.

Our imports of ground and calcined gypsum and of manufactures of gypsum come largely from Canada, with Europe and other regions participating in the business. In view of the importance of the gypsum industry in the lake states, it is unlikely that foreign supplies, except some Canadian, moving in by rail, would reach the interior.

The conclusion reached is, then, that there would be extremely little use made of the St. Lawrence waterway for the movement of gypsum products and that the greater part of any use that might be made would be "occasional."

XIII. Slate and Marble

1. *Slate.* Slate is used principally for roofing and other structural purposes and in the electrical industry. Production is in limited areas in eastern Pennsylvania and Maryland, eastern New York and western Vermont, in south central Maine, and in Virginia. Freight rates now limit the distribution of roofing slate to points east of the Mississippi River. Little slate is used in the South. In the case of slate used for electrical and school purposes, freight charges are not so much of a limiting factor.

Careful study of the points of production in relation to important points of consumption indicates that the only slate, if any, which could possibly use the St. Lawrence route would be that produced in Maine. In all other cases an all-rail haul would be more advantageous, in view of the difficulty of handling slate and the roundabout character of the St. Lawrence route. The only slate which Maine produces in significant amounts is that used in the electrical industry, and, on further consideration, it becomes evident that this could not advantageously move via the roundabout water route, as this would require in all cases a rail haul at point of origin and a final rail haul in reaching many destinations, and is a grade of traffic requiring fairly frequent and expeditious transportation service. Handling costs are also heavy.

Our exports of slate go mainly to Canada and these would doubtless continue to go directly through St. Lawrence and Buffalo gateways. Other exports would use Atlantic gateways.

Imports are of minor extent.

Canadian production, in Quebec, is of small extent and offers no opportunity for use of the waterway.

2. *Marble, and other building or monumental stone.* Our imports of marble, breccia, onyx, and other unfinished and finished building and monumental stone reached approximately 125,000 tons in 1925-1927, a figure considerably higher than those for the years immediately preceding. Most of our imports, which come in largely in the unfinished state, are of interior marble, and Italy is our chief source of supply. Belgium, France, and Greece are also important; Mexico sends us onyx; and Guatemala, which now sends us some imports, is said to have possibilities of an important development. New York, the chief wholesaling point, accounts for about nine-tenths of the imports. Only small quantities move in through Gulf and Pacific ports. This last fact is indicative of the importance of the importer's function and suggests rather clearly that shipments would not be made directly into the Lakes unless there were agencies in the lake cities able to handle them. We may,

to be liberal, assume that in two or three of the largest cities wholesalers would be found who could handle import shipments, though this does not provide for the many other important and less important lake cities. Back hauls, rail or water, would necessarily be of limited extent. The interior market is, in fact, likely to depend very largely on domestic supplies or on imported supplies brought in through the New York market. Allowing for growth but taking into account the factors named, the effects of the closed season, and the greatly inferior frequency of service into the Lakes compared with New York, we may set down 10,000 tons of imports per annum as the likely maximum use of the waterway.

Domestic production of marble is chiefly in Vermont, Tennessee, Georgia, Alabama, Mississippi, and Alaska. Obviously, no use could be made of the St. Lawrence for the movement of exports from these points. As for domestic movements, it is also apparent that there would be no occasion to ship to a coast point for movement by water from there. The costliness of transfers and the necessity for careful bracing in cars to prevent damage to the finished product make it advisable to load at quarry or other manufacturing point through to destination. Frequently delivery time is an important consideration and in some cases contracts call for specified deliveries. To be sure, manufacturers or wholesalers at important ocean or lake ports might draw upon stock supplies for shipment to other points reached by water, but even here the necessity for specified delivery, the small saving, if any, in rates, and the inability to use water transportation service effectively for miscellaneous shipments, many of them small in amount, make it unlikely that such "intercoastal" movements would occur.

Canada's imports of stone, marble, and slate are grouped together in her foreign trade statistics. Eight-ninths of her imports are from the United States and practically all of her exports go to the United States. The latter need not concern us. The imports, which are largely from the United Kingdom, come in at the present time almost wholly at Montreal. It is

conceivable that some would find their way around into the interior Canadian lake cities. We have set such import traffic for the St. Lawrence at 3,500 tons per annum.

Indiana limestone may be considered separately. The only possible movement of this product via the St. Lawrence would be down to Montreal and Quebec and other cities directly on the St. Lawrence. The heavy loading and handling costs, the possibility of damage, especially to the "cut stone," and the need for prompt service all suggest that, once loaded on or in the freight car, the stone will stay there until destination is reached. The various by-products of the quarries, used as fertilizer, in the steel and glass industries, etc., move no great distance and would furnish no traffic for the St. Lawrence route. Imported structural limestone is said to be of inferior quality. It is used mainly in the cities along the Atlantic seaboard. Present imports are very small, indicating the competitive strength of the American stone in the markets most easily reached by the European products. We do not believe this foreign limestone could meet the competition of Indiana stone in the interior of the United States.

XIV. Asphalt and Bitumen

Our imports of natural asphalt, obtained almost wholly from Trinidad, Tobago, and Venezuela, have fallen off in recent years, owing to the competition of petroleum derivatives. Thus imports averaged 125,000 tons in the years 1925-1927, as against 177,000 tons for the years 1910-1914, while our railroads have originated 2,500,000 tons of the petroleum product in a recent year. So long as Gulf Coast, Mexican, and California petroleum with its asphaltic base continues cheap, it seems unlikely that the natural asphalt can compete with it effectively.[52] The demand for asphalt is of a seasonal character, a fact with which importers must reckon. Imports have come in principally

[52] See Lilley, E. R., *The Oil Industry,* 1925, p. 487.

through New York, with a considerable volume passing through the Virginia and Gulf ports.

Owing to the problematical character of our future supplies of petroleum, it is impossible to make predictions with any degree of certainty. We can assume, however, that for a good many years to come Mexican and other asphaltic base, low-grade petroleum will be available, and that this will move to the Gulf and Atlantic coast refineries. Bearing in mind this fact and the inability of asphalt to stand high transportation charges, we believe that not more than 15,000 tons of natural asphalt could find its way in over the St. Lawrence route.

Canada's imports are almost wholly from the United States. Questions as to possible movements of petroleum asphalt have been considered elsewhere.

The use of the so-called vein asphalts in the manufacture of special paints and insulating and acid-resisting coatings suggests movements of small quantities to places which would not permit use of the St. Lawrence route.

XV. Stone, Sand, and Gravel

Crushed and other common stone is the sort of low value, bulky commodity that can use water transportation to advantage under favorable circumstances. The seasonal character of the demand for much of it also fits in with the season of operation on the St. Lawrence. However, so widespread is the production and so quickly do transportation charges eat up the value of the stone that shipments, except under very favorable circumstances, are almost wholly local in character. The growth in the volume of stone carried by the Great Lakes carriers, from 3,800,000 tons in 1915 to 11,350,000 tons in 1925, shows principally the effect of largely increased demand and favoring circumstances, the latter attributable to production on a large scale and at convenient points of water shipment, with large markets reached for the most part without an additional rail haul. These facts and the absence of any large

movement of stone at present between the United States and Canada in the territory reached by the St. Lawrence suggest very strongly that no significant use would be made of that route after its improvement. Some small amounts might be moved between local points, but these could in most instances be as well carried with the present depth of channel.

Much the same can be said of sand and gravel. It is reported that 237,000 tons of sand were transported on the St. Lawrence River in 1925, though the figures available do not indicate where or how far this sand went. Large quantities of sand are available for distribution between Lake ports; such sand would be a serious competitor of any Canadian sand which might attempt to move in over any part of the St. Lawrence. The wide distribution of supplies and the low value of most sands make it likely that only under exceptional circumstances would sand move over the St. Lawrence in a manner different from that in which it now uses that route. Sand sometimes is brought in or taken out as ballast, but the amounts are not large and such traffic cannot properly be included in a survey of this sort. The same considerations apply to gravel.

To take care of any small amounts of these materials which might for one reason or another be shipped over the deep waterway we may include in our total estimate of United States traffic 5,000 tons of exports, and 5,000 tons of imports. No allowance will be made for Canadian traffic in this class of materials.

APPENDIX I

MISCELLANEOUS RAW MATERIALS AND MANUFACTURES

I. Cotton and Cotton Manufactures

1. *Raw cotton.* Just about 1 per cent of either the consumption of domestic raw cotton or of the value added by manufactures is attributable to cotton mills situated in the states of Illinois, Indiana, Ohio, Michigan, and Wisconsin. This fact and the roundaboutness of the St. Lawrence route compared with the direct rail haul from Southern cotton production points clearly indicate that no appreciable use could or would be made of the St. Lawrence route for the domestic movement of cotton.

Would it be used for the movement of cotton into Canada? In the years 1924-1927 Canada imported on the average about 60,000 tons of raw cotton from the United States; her imports from other countries are of negligible extent. Factories for the conversion of this into yarns, threads, etc., are for the most part in Ontario and western Quebec, and in the majority of cases are on or near navigable water. In 1927, over four-fifths of this cotton entered Canada via the Michigan, Buffalo, and St. Lawrence customs districts, indicating an all-rail movement on this, if not on practically all, of Canada's cotton imports. In view of the relatively small size of individual shipments, the number of sources from which obtained, and the high value of cotton in relation to its weight, it appears altogether unlikely that any use would be made of the roundabout St. Lawrence route. The season of shipment also does not favor any extensive use, since the supply is lowest in the spring and early summer months, picking up with the coming of the new crop in August and thereafter. Also it is very doubtful

whether there could be any appreciable saving in transportation costs (assuming that a convenient packet service would develop between the Gulf and South Atlantic ports and the Great Lakes), for the cost of getting to shipside alone would probably be more than one-half of the rail rate to destination. It is our judgment that opening the St. Lawrence waterway to deeper draft vessels would work no appreciable change in the routing of Canada's imports of United States cotton.

We import considerable amounts of long staple cotton, mainly from Egypt, and of short staple cotton from the Far East, Mexico, and South America. Could any use be made of the St. Lawrence in bringing this cotton in? Statistics show that the cotton mills in the Great Lakes region use probably les than 1 per cent of this imported cotton, amounting to something like 1,000 tons. Massachusetts and New York together preëmpt the imports of long staple, while sharing with Pacific Coast and, to a less extent Virginia ports, the imports of short staple. It is altogether unlikely that any small purchases made by interior cotton mills could be routed via the St. Lawrence.[1] Canada's imports from countries other than the United States are wholly negligible.

Cotton waste should not be overlooked. Our imports of this product have varied greatly in recent years, being, for example, nearly 40,000 tons in 1923 but averaging only 15,000 tons in 1925-1927. This waste is imported mainly from Europe and the Far East and is of the variety used in machine wiping. Massachusetts and Philadelphia figure prominently as ports of entry, suggesting a movement which could use the irregular and infrequent service likely to be available on the St. Lawrence route. If we make our calculations in terms of a total importation of, let us say, 30,000 tons, we might suppose that as much as 3,000 tons would move in via the St. Lawrence.

[1] The reader may ask whether cotton mills would not spring up in the lake states and thereby make for use of the St. Lawrence waterway. Such a development is, however, clearly beyond the bounds of probability.

Our exports of cotton-mill waste and of cotton rags (other than paper stock), though quite extensive, would not offer traffic for the St. Lawrence, inasmuch as their marketing is closely associated with the cotton manufacturing industry.

Our trade in cotton and wool paper stock is considered in connection with our analysis of the paper industry.

2. *Manufactures of cotton.* Our export trade in cotton, yarns, threads, textiles, etc., would require no use of inland waterways. The only exception might be exports to Canada, but here it appears rather unlikely that any effective competition could be developed, in service and rates, with the direct all-rail routes. Would the products of our own mills move inland via the St. Lawrence? So far as mills in the cotton-growing states are concerned, the answer is clearly a negative one. Many of the shipments must be made with great promptness and regularity, while even in the case of shipments for stock it is fairly certain that there would be little or no saving over the all-rail route, with direct shipments from factory door to warehouse, in a route that would require a fairly long originating rail haul before the goods were placed on board ship. But many of the New England mills are located on, and none at a very great distance from, tidewater. What of shipments into the interior of both the United States and Canada from there? So far as shipments requiring expeditious service are concerned, no use could be made because of the difference in delivery time. Shipments for stock could proceed in leisurely fashion and doubtless could use the route if there were a significant saving in costs. The standard rail rate on dry goods, Boston to Chicago, is $1.42 per hundred pounds, and in the case of some items is as low as $1.06; no other charges are incurred. What water rate could be made is problematical, of course. The intercoastal rate on dry goods has recently been 75 cents, but this is a highly competitive rate and one in which allowance for seasonal operation does not have to be made. It is doubtful whether, assuming that a packet service would develop to and

from the Lakes, a rate under one dollar a hundred would be profitable. To this rate must be added the cost of getting to and from shipside and whatever the bunching of receipts and shipments represents in the way of costs as compared with a more regular in and outflow. To points east of Chicago the differential would be less than that to Chicago, while to Duluth, if the packet rate were the same as to Chicago, the differential would be more, owing to the higher rail rate. A rail haul to points beyond Chicago and Duluth would largely preclude use of the route because of the costs involved. It is also to be borne in mind that differentials of 13 cents a hundred, Boston to Chicago via the standard rail-and-lake route, and of 18 cents via the differential rail-and-lake route, fail to attract traffic in competition with the standard and differential all-rail routes.[2] Furthermore, any goods to be marketed in the spring season would have to move into the wholesaler's warehouse during the season when navigation is closed.

Before going further, let us look briefly at our imports of manufactures of cotton. These are quite extensive in point of value but on a tonnage basis constitute a relatively small item.[3] Most of these come from Europe, though a considerable amount comes from the Near and Far East. Here again it is possible that the big wholesale houses at the lake ports, particularly Chicago, could work out a saving on their direct importations, during the summer months, of goods for stock. The infrequent and irregular service likely to be available from most trade regions would not be a serious deterrent. At times

[2] The only important movement of textiles on the Great Lakes is that from Buffalo to Duluth, and this averaged only a little over 5,500 tons in the years 1924-1927. Occasionally Erie, Cleveland, and Detroit make small shipments by water and a small amount goes across the lake to Chicago from factories at St. Joseph and Muskegon, Michigan. In all, less than 9,000 tons of textiles moved on the Great Lakes in 1927, while in that year some 313,000 tons of textiles were originated by the railroads of the eastern district.

[3] Thus in 1924 our imports aggregated \$91,000,000, representing according to our estimate about 16,000 tons of traffic.

the Midwest clothing manufacturer might also procure his foreign supplies in this manner, though it is doubtful whether such a practice could become very general.

Without laboring the point further, for after all the tonnage is inconsiderable, we may set down, purely as an estimate, 5,000 tons per annum to represent American and Canadian use of the St. Lawrence route for both domestic and import movements. This figure is liberal enough to allow for expansion of trade in the decade or so to come. Of this amount, 2,500 tons represent United States imports, 1,000, Canadian imports, and 1,000, United States inbound domestic movements. An additional 500 tons of Canadian export traffic may be set down.

II. Wool and Wool Manufactures

1. *Wool.* Of the manufacture of woolen goods about 92 per cent takes place in the East and in a few other states not adjacent to the Great Lakes, while that of worsteds and carpets is almost wholly an Eastern affair. These facts largely supply the answer we seek in the case of imported wool. Of the 8 per cent of our imported wool which may be assumed to be used in the lake states, at best only about 16,000 tons per annum at the present rate of importation, much the larger part moves in during the season when the St. Lawrence route would be closed to navigation. Most of the imported wool is purchased at Boston (the country's greatest concentration point) and at New York from agents representing the foreign shipper or from our own wool merchants in those places. Since it is only the large shipments that could advantageously be routed direct from Argentina, etc., to the inland purchaser, and since these move predominantly in the closed St. Lawrence season, it is difficult to see how any appreciable amounts of foreign wool could move over the St. Lawrence waterway. The foreign shipper also desires to make delivery as soon as possible in order that he may get his money, and for that reason would prefer the use of an ocean port to an interior one. It is con-

ceivable that a little British and other wool would move in directly. To be on the safe side, we will set down 2,000 tons of imported wool as likely to use the St. Lawrence waterway. This figure allows for a considerable growth in our total imports.

Our exports of wool are of negligible amount.

Is there possibility of domestic wool moving from point of production to market or consumption point via the St. Lawrence? Domestic production of wool averaged 147,000 tons in the years 1923-1927. Production, though widely distributed, is largest in such western and southwestern states as Wyoming, Montana, and Texas. The present production of the Northwestern states may be liberally placed at 65,000 tons per annum. Much of the Western wool is shipped to Portland, one of the largest primary markets, and is thence shipped east by water.[4]

Western wool, destined to Boston and other eastern markets, may also take advantage of combination rail-lake-rail rates applying to Duluth and other lake ports, with transshipment to rail at Buffalo. These rates are considerably lower than the all-rail rates. Practically all of the wool tonnage moves in May, June, and July, thus favoring the use of water transportation. Wool is, however, a commodity of high value (the value of a car of wool exceeds that of any other commodity commonly moving in carload lots), and so other factors than transportation costs apparently exert a large influence over its routings.[5]

[4] In *Wool Rates Investigation, 1923,* it was stated that 80 per cent of the wool produced west of 110° meridian (which cuts Montana in half) moves to Boston via the Panama Canal (91 I. C. C. 235,279). For a number of reasons, more and more of this wool is being sent west for marketing and shipping. Very low intercoastal water rates have played a large part, of course.

[5] A differential of $10 a ton (50 cents a hundred) diverts wool to the Panama Canal route; of $5 a ton to the Gulf ports from Texas points of production; and of $3 a ton to the Great Lakes routes. But, with respect to the last, scarcely 2,000 tons were shipped from Duluth to Buffalo as an average in the years 1920, 1922, and 1923. From Chicago in the period 1920-1925, rail shipments east aver-

Could a rail-St. Lawrence rate via Duluth (and perhaps Chicago and Milwaukee) to Boston be worked out that would attract traffic in considerable quantities? Such a combination rate would have to meet the competition of two more direct routes, one giving the superior rail service and charging "standard" rates, and the other giving slightly inferior rail-water-rail service and charging differential rates. It would also have to meet the competition of the Panama Canal route. How much, if any, of this Montana, Wyoming, and Colorado wool traffic would the St. Lawrence route attract?

The answer is difficult; but it is our belief that the following factors clearly indicate that a very slight use would be made of the St. Lawrence route for the movement of domestic wool: (1) the small use of the differential routes at present; (2) the need in most cases for rapid transportation and certain delivery; (3) various commercial practices—such as transiting and buyers' efforts to gauge the market—which put other considerations above small differences in transportation costs and otherwise exert a control over routing; (4) the roundaboutness of the route, especially since on reaching Buffalo shipments would be so near to ultimate destination; and (5) the probability that the rate available would not be much lower than the present differential rate. Occasional shipments might go around if a fairly frequent packet service with rates a little lower than the differential rail-lake-rail rates then obtaining developed. Perhaps we can set down 2,000 tons per annum as a liberal maximum figure, under the assumptions made.

Canada has imported in the last few years some 8,000 tons of wool, much of this coming from the United States. Her wool manufacture takes place in large part in Quebec and the Maritime Provinces. There is no promise of a large wool movement into Canada via the St. Lawrence. Conditions would favor a movement of Western wool down to Montreal if the

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aged 33,000 tons while lake shipments were practically non-existent. In the five-year period 1912-1916, rail shipments from Chicago averaged 54,017 tons and lake shipments 329 tons.

packet service suggested above were to develop. Some foreign wool might also make use of the St. Lawrence in entering Canada. Western Canada, exclusive of distant British Columbia, produced 2,400 tons of wool in 1927. Bearing in mind the possibility of an increase here and of some use of Western American wool, we may again set down 2,000 tons as the likely maximum Canadian use of the waterway. Of this 1,500 tons would represent a lake movement and 500 tons imports from overseas.

Before passing to manufactures of wool we may consider for a moment a group of low value waste products (rags, noils and waste, tops, etc.). Our imports under this head were about 16,500 tons in 1924-1927 and our exports about 6,700 tons. Since these articles are re-worked into woolen goods, our general findings with respect to movements of wool indicate that no appreciable use could be made of the St. Lawrence in this instance. Wool rags used in the manufacture of paper are a more important item and are considered in connection with the traffic analysis of the paper industry.

Canada's imports of noils, waste, and tops are quite extensive and come mainly from the United Kingdom. Though the location of her wool manufacturing industry does not particularly favor use of the St. Lawrence waterway, it is possible that some use could be made of it for this low grade traffic. Canada's importations averaged about 3,700 tons in the years 1924-1927. Allowing for growth of total importations, we may set down 2,000 tons per annum as a liberal maximum estimate of the use that would be made of the water route.

2. *Manufactures of wool.* Embraced under this head are principally cloth and dress goods and other wool fabrics, carpets of wool, and wool wearing apparel. For convenience, yarns are also included. Our exports of these products are, from a tonnage standpoint, of small extent and in view of the location of the industry and the type of transportation service required, no use of the St. Lawrence is indicated. What is said applies

as well to Canada, whose exports under this head are, in any event, of slight extent.

Total American and Canadian imports under this head probably do not exceed 18,000 tons per annum. In both cases the bulk of the imports are from Europe, mostly England. New York is the principal port of entry for the American importations, though in the case of the finished products a considerable amount enters at interior customs districts. The analysis here is much the same as that with respect to manufactures of cotton. The greater part of such a high class of traffic as this must move with rapidity and certainty; it is only the large wholesale houses and to a less extent manufacturers of clothing that could make any important use of the St. Lawrence route for direct importations. Under the circumstances, an allowance of 3,000 tons per annum would appear to be distinctly liberal. Of this 2,000 are attributed to the United States and 1,000 to Canada.

III. Flax and Flax Products

Our imports of hackled and other flax averaged in the years 1925-1927 some 6,200 tons, of which Europe supplied 90 per cent, and Canada, the Far East, and Africa the rest. New York and Massachusetts ports account for nine-tenths of the entries. The Canadian importations move across the boundary without possibility of use of the St. Lawrence.

The production of linen goods is pre-eminently an Eastern affair, Massachusetts leading by a wide margin, with New York, New Jersey, New Hampshire, etc., also of importance. Only three establishments are credited to the Middle West by the Census of Manufactures, 1923, two in Minnesota and one in Michigan. These conditions clearly point to a continued use of Eastern coast ports for imports of flax. There could be no substantial inducement to cause efforts to be made to bring flax, other than Canadian, directly into the interior.

We export no flax and our exports of manufactures of flax are of such small extent and are produced so predominantly in the East that no significant use could be made of the St. Lawrence route.

We import a considerable quantity of manufactures of flax and the related products—hemp and ramie. Some 23,000 tons were imported on the average in 1924-1927. Practically all of these products, which are of a higher grade than those we produce, come from Europe, especially Ireland. New York is the great port of import, though about 2,000 tons were credited in 1927 to interior customs districts.

The situation here is much the same as that in connection with cotton and woolen goods. While most of the imports would continue to move through the coast ports, particularly New York, the large wholesale and mail-order houses in the Middle West, especially those located at Chicago, might find it possible to move in a season's supply directly from abroad. Only one of the year's two seasonal peaks could be served in this way, however, and it would not always be convenient or possible to plan ahead or adapt shipments so that full use could be made of the direct water movement. An allowance of 2,000 tons per annum seems, therefore, distinctly liberal and allows for substantial growth in total imports.

During the war Canada greatly increased her production of flax for fabric, Russia having dropped as the leading producer. Her production, which occurs in Ontario, averaged 800 tons of fiber in 1924-25, while that of tow jumped from 19 tons in 1924 to 2,325 tons in 1925 and 2,075 in 1926. Exports averaged some 875 tons in the years 1924-1927, of which seven-tenths were taken by the United States and most of the remainder by the United Kingdom. It is conceivable that some of the exports to Europe could be gathered in at Toronto, which appears to be the natural port at which this commodity would be assembled. Assuming that the Canadian production will continue, we might set down, as a liberal estimate, 500 tons of traffic under this head.

Canada's imports of manufactures of flax, on which no statistics are readily available, would require the same type of service as our own. Montreal serves, however, as a great commercial center, much as Chicago does in the United States, and distribution from there would certainly be by rail. Assuming that Toronto and other inland cities would expand as commercial centers, we may set down, as a liberal estimate, 500 tons of direct imports of manufactures of flax via the St. Lawrence.

IV. Miscellaneous Textile Products

Linoleum and oilcloth are exported in sizeable quantities, but the industry is so predominantly an Eastern one (Pennsylvania and New Jersey alone accounting for over 70 per cent of the production) that no important use of the St. Lawrence is indicated. A little might enter Canada by packet boat, but this does not seem very likely. Artificial leather, waterproofed cloth, and window shade and book cloth also are unlikely to use this route, partly for the reason given above and partly because of the high value of the product, the small size of shipments, etc

Our imports of linoleum, tracing cloth, and other coated, filled, or waterproofed fabrics come almost entirely from Europe, and New York stands out as the port of entry. It is conceivable that some of these imports could be brought directly into the Great Lakes region, particularly in the case of linoleum. Without attempting a refined analysis, we will set down 750 tons as the maximum of such traffic. By far the greater part of this would be linoleum. Our estimate is liberal enough to include any direct Canadian imports.

Oakum, used for marine calking and by plumbers, enters into foreign trade in only limited amounts and gives no promise of furnishing any traffic for the waterway.

We import, mainly from the Far East, a considerable amount of materials used in the manufacture of straw hats and export a small quantity of such material. The Eastern states figure so prominently in the manufacture of straw hats that it is

unlikely that any of this material could be brought directly into the lake states. For the same reason, our exports of straw hats and material therefor are wholly unlikely to involve use of the St. Lawrence route. Nor does it seem necessary to inquire seriously whether hats, hat trimmings, etc., would move in over the route. The amounts are too small and the character of traffic too high grade to make use of the waterway likely. In Canada the situation is somewhat different. We will therefore set down 200 tons as a liberal estimate of the use Canada could make of the route.

We have imported in recent years somewhere in the neighborhood of 4,000 tons of mats and mattings and other manufactures of fibers, textile grass, straw, etc. Our supply has come largely from China and Japan. New York is relatively unimportant as a point of import. This is a low grade of traffic, a fact which further suggests that use might be made of the infrequent, irregular service likely to be available between the Orient and the Great Lakes. We may assume, therefore, that as much as 750 tons of this class of product would enter via the St. Lawrence, representing occasional receipts of the big wholesale houses in the Middle West and the interior of Canada. Of this, Canada would receive one-third. For the most part, however, these houses would depend on other routes.

We export some fiber, grass, and straw products, largely to Latin America, Europe, and Canada. Production takes place to a considerable extent in the lake states. Production reaches its peak in the winter months. But little use of the St. Lawrence is indicated; we may, however, set down 150 tons as a liberal estimate of traffic available.

Horsehair, tails, and manes, used in the manufacture of haircloth, upholstery, etc., have been imported in the amount of about 2,400 tons in recent years, in large part from South America. Pennsylvania produces nearly nine-tenths of the haircloth manufactured in the country, a fact which points to the conclusion that no significant use would be made of the St. Law-

rence for moving either the raw materials in or the finished product out. Artificial horsehair, used in the manufacture of millinery, moves in too small quantities to require consideration.

Other animal hair, principally cattle, has been imported, mainly from Europe and Canada, in amounts averaging about 7,200 tons in 1925-1927. Imports are not likely to show growth. This hair is used for pipe coverings, as binding for mortar and plaster, and, mixed up with other materials, is made up into certain textile products. Under the circumstances, we might set down 750 tons as representing the maximum possible use of the St. Lawrence route. Our imports of manufactures of horse and cattle hair are too small to require analysis.

Our exports of cattle and other hair amounted to 8,500 tons in 1925-1927. Europe is our best customer. Much use is made of Philadelphia, Maryland, and Virginia ports, suggesting that possibly use could be made of the less plentiful and varied service likely to be available on the Great Lakes. We may set down 2,000 tons per annum as a liberal estimate of the use that might be made of the St. Lawrence route. This figure is large enough to include any of our small exports of manufactures of animal hair that might find their way to the route.

Our imports of human hair, largely from the Orient, are unlikely to furnish any appreciable amount of traffic for the St. Lawrence route. Much enters at Texas points, where apparently it is made up into press cloth, used in the extraction of cottonseed and other oils. Ninety per cent of our imports of manufactures of hair takes place at New York. In view of the Far East origin of the greater part of our imports of hair and hair products, it is necessary to conclude that any use that might be made of the St. Lawrence route for direct importation would be of negligible extent.

Canada's foreign trade in animal hair is almost solely with the United States and so has already been taken into account. Her exports and imports of manufactures of hair are of small extent and unlikely to require any significant use of the St. Lawrence route.

There are certain unimportant items under the textile group—absorbent cotton, elastic goods, etc.—which have not yet been accounted for. Neither the points of production (largely in the East and South) nor the markets (largely Latin America) would permit of use being made of the St. Lawrence route, and at best the amounts are of minor importance.

V. Cordage Materials

The principal materials used in the manufacture of this general class of products are manila and sisal, with istle, kapok, jute, hemp, and cotton also of some importance. Jute and cotton are considered in other groupings. Our task is, then, that of determining what use could be made of the St. Lawrence route for bringing in the other materials mentioned and for the movement, in foreign trade or otherwise, of the finished products.

1. *Manila.* Manila has been imported in recent years in amounts approaching 70,000 short tons. Practically the entire supply originates in the Philippine Islands. It is distributed along our coasts, New York and Massachusetts taking a great deal, and considerable coming in at Pacific coast ports and at New Orleans. Small amounts are credited to the interior customs districts along the northern border. Canada's imports have averaged only 2,400 tons in recent years and of these 95 per cent came from the United States. In some years practically the entire Canadian supply has been obtained from the United States.

Massachusetts and New York stand out as points of manufacture of cordage, with New Jersey, Pennsylvania, and other Eastern states also important. In the Middle West production of cordage (binder twine is discussed later) takes place largely at such points as St. Louis, Peoria, Newark, and Xenia. In Canada production takes place at Montreal and Lennoxville, Quebec, at Brantford, Kitchener, Welland, and Fort William, Ontario, and at New Westminster, British Columbia. Of these points only Montreal, Welland, and Fort William are directly on the St. Lawrence route.

Our analysis of other commodities imported from the Philippines, principally sugar, and of our trade with the Philippines and the general trade region of which the Philippines are a part, does not lead to the belief that there would be any regular liner service established between that region and the Great Lakes, certainly none of any frequency. Would a commodity such as manila, which, after all, moves in rather small quantities, make use of such irregular, uncertain vessel service as might be available?

The answer is undoubtedly, no. Middle Western users would find it troublesome to adapt their purchasing to such service, assuming that there might be some small saving in transportation charges. But, as we have seen, the important American inland points of manufacture are back from the Lakes. A delivering rail haul from lake port definitely precludes the use of the route. It is altogether likely that present trade channels and marketing practices would continue substantially unchanged. Montreal, Welland, and Fort William might, theoretically, obtain some of their supplies direct from ships passing up the St. Lawrence, but so uncertain would the vessel service be that it is doubtful whether other than the most "occasional" use would be made of it. Apparently, Montreal now receives little or no manila by water.

The important considerations bearing on our general conclusion that no significant use would be made of the St. Lawrence route are, then, the small volume and relatively high value of shipments, the location of plants, the inadequacy of the vessel service likely to be available, and the competition of the effective marketing practices now in use.

2. *Sisal.* Sisal, almost the sole material used in the manufacture of binder twine, is obtained in largest part from Yucatan, though in recent years other sources of supply (the Far East and Africa, as well as some Caribbean countries) have become of increasing importance. Our imports for 1925-1927 averaged 140,000 short tons. Of the imports, 58 per cent passed through New Orleans, 21 per cent through New York, and 19

per cent through Massachusetts points, leaving but 2 per cent for all the remaining customs districts.

The manufacture of binder twine is a rather concentrated industry in which the United States and Canada clearly lead, supplying 90 per cent of the world's needs. One American concern, with plants at Chicago, St. Paul, Hamilton, Ontario, Auburn, New York, and New Orleans, as well as in various foreign countries, accounts for 55 per cent of the domestic production. The second largest company produces 25 per cent and the remaining 20 per cent is produced by various small concerns and by the state penitentiaries. Canadian plants, other than the one at Hamilton, are situated at Brantford, Montreal, Welland, Fort William, and New Westminster, British Columbia. Canadian imports of sisal averaged 16,200 tons in 1924-1927, of which 82 per cent came from the United States and much of the rest from the United Kingdom.

Bearing all these facts in mind, what is the possibility of bringing sisal in via the St. Lawrence? First let us note the alternative routings. To reach Chicago and the Middle West generally from Yucatan, the natural route is by boat or rail to New Orleans and thence inland by rail, water, or rail-and-water. New Orleans has, in fact, long been of chief importance as a port of entry. Thus in 1914, 107,000 tons, or one-half our imports, passed through that gateway, and in many years the percentage has been considerably higher. Some indication of the destination of the sisal received at New Orleans and not worked up there is found in tracing movements via the Mississippi-Warrior River service. In 1921, of a total movement of 39,369 long tons, 11,960 tons moved to Illinois points, 13,812 tons to Indiana points largely in transit to Illinois, 9,084 tons to Missouri, 2,664 tons to Minnesota, and small amounts to Wisconsin and Michigan.[6] Could the St. Lawrence route meet the rates and service offered via the Southern gateways?

[6] U. S. Engineers, Port Series No. 5, *The Port of New Orleans*, 1924, p. 221.

It seems fairly evident that, after a long, roundabout haul from a Mexican shipping point to the Great Lakes, sisal could not be moved back by rail to interior points. The distance from Progreso, Mexico, to Chicago via the proposed St. Lawrence route would be 4,777 statute miles. The distance from Progreso to Chicago via New Orleans is 1,570 miles (640 miles by water and 930 miles by rail). The combined rate and attendant costs would be prohibitive. Even a short rail haul would be out of the question, and at the lake ports themselves a trucking haul from public docks is an expense to be weighed against the advantage of rail delivery at warehouse door. Our question becomes, then, one of determining what use could be made of the St. Lawrence for delivering sisal at the lake ports. This question, we find, falls into two parts; one relating to liner service, the other to the charter trade.

Our first problem therefore is that of considering how the import movement of sisal would reach Chicago, Hamilton, Welland, and Fort William if the St. Lawrence route were available. Fort William would be out of the range of any possible liner service, and it is doubtful whether Hamilton, because of its size and proximity to Toronto, would be a regular port of call for liners. Welland would, of course, be directly on the route. The Welland plant is, however, a subsidiary of a company having its principal plant at North Plymouth, Massachusetts. It is altogether likely, therefore, that this concern would bring all its shipments in at a single ocean port and ship from there the requirements of its Canadian plants. The present problem narrows down, then, to one of determining whether liner service would be used in bringing sisal to one company's plant at Chicago. It is not improbable that some use could be made of such service, but we do not regard it as likely that this use would be at all extensive, for several reasons. (1) The saving in rates could not be large and might be of negligible extent. (2) The service would be less regular and therefore more troublesome to use than that via the Gulf, which has the added advantage of being available the year round. (3) The

necessary use of the Gulf for a large part of this concern's receipts of sisal would encourage its use for other receipts of the commodity unless there were a large disadvantage in doing so, as there is not in this case. (4) A considerable part of the sisal is now received during the closed season, making it disadvantageous to re-distribute receipts so as to make use of a seasonal route possible. (5) Finally, as stated above, there would be the cost of trucking from public dock to plant, an item of considerable importance.

Much more likely is it that such use as this particular concern could make of this route would be through chartered vessels. Our analysis of the movement of agricultural implements and machinery indicated that there is a possibility that the largest American producers could use chartered vessels on a small part of their business. Only one of these companies engages in the manufacture of binder twine. It is not unlikely that these vessels could bring back some sisal for this concern's plants at Chicago and Hamilton and possibly for reshipment from Chicago to St. Paul, where another large plant is situated. Owing, however, to the increasing use of the combine-harvester, the consumption of fiber is decreasing. An allowance of 15,000 tons of traffic under this head would appear to be liberal. Roughly two-thirds of this would have to move to Hamilton, production of twine at Chicago having recently decreased. The factory at Fort William is not, of course, of sufficient size to warrant cargo importations of sisal and other raw materials.

As for the interior Canadian manufacturers, it appears likely that they would continue to depend on present routings, mainly through the United States. In other words, these concerns would find it no more advantageous than would ours to put up with an infrequent and seasonal vessel service when the savings it would offer, supplementary rail hauls considered, could not at best be very significant. For these reasons we make no allowance under this head, though if liner service were established some slight use might be made of it.

But, it may be said, this analysis has been too much in terms of Yucatan sisal, whereas sisal from the Far East and Africa would move in over the St. Lawrence. For reasons developed in Section VII (see pp. 577-78.) below in connection with the analysis of other commodity movements from the Orient, it does not seem likely that liners reaching this country from the Far East would penetrate into the Great Lakes. This may also be said of liner service from Africa and that general trade region, from which we receive almost no materials which could be brought directly into the lake states. The only possible movement of sisal from these regions via the St. Lawrence would be the cargo movements mentioned above, and our allowance there was liberal enough to include any receipts from these newer sources of supply of sisal.

As for the dealers, the production of binder twine is so highly concentrated that there is relatively little of the demand for them to supply. Direct importation into lake ports, with storage and delivery, by rail or otherwise, from there to local production points is unlikely to prove an attractive opportunity, particularly in view of the seasonal closing of the route. There is every reason to expect that the dealers will continue to operate from the coast points, whence they can distribute freely by rail in all directions.

3. *Other vegetable fibers.* What has been said of manila applies equally well to kapok, imported in amounts averaging less than 10,000 tons in recent years and coming mainly from Java and Madura; maguey, coming in very small amounts from the Philippines; and other vegetable fibers, coming mainly from the Far East, including Australia. Istle, which originates mostly in northern Mexico, is governed by the same general considerations as is sisal from Yucatan. The natural gateway is across the border by rail or through Gulf ports.

4. *Rope and cordage manufactures.* Our exports of cordage, exclusive of binder twine and jute cordage, did not reach 6,000 tons in 1927. Of these much the greatest part went to Latin

America, with Canada taking about a fifth, the Far East a little, and Europe very little. In view of the location of our markets in relation to the point of manufacture, it does not require lengthy calculations to show that no significant use of the St. Lawrence route would occur. Also the high specific value of cordage and the small size of individual shipments require the use of frequent, expeditious, and regular routings.

Our exports of binder twine are a much more important matter. In the years 1925 to 1927 these averaged about 18,500 tons. But over half have gone to Canada, a movement unlikely to require use of the St. Lawrence.[7] A fairly large quantity moves up from Chicago by boat to the Lake Superior ports,[8] while the eastern Canadian demand is met from the plants at Hamilton, Welland, etc. A little appears to move across from New York points and from the other border states, but in no case can use of the St. Lawrence be foreseen.

Our other important markets are in Europe and South America, especially Argentina, with small amounts going to the Far East. While the bulk of binder twine shipments would undoubtedly seek the frequent vessel service at coast ports there is a possibility that the cargo shipments of agricultural implements and machinery, mentioned above, would include some binder twine.

Bearing in mind the export situation, we might set down 2,500 tons of traffic in binder twine, of which the greater part would be used to fill in full cargo shipments of other products. Of this total perhaps 1,000 tons would originate at Chicago and 1,500 tons at Hamilton.

Our imports of binder twine are of relatively small extent averaging 5,700 tons in 1925-1927 and come mainly from Canada, with some from Mexico, Cuba, and Europe. The Canadian

[7] See p. 569.

[8] The fact that shipments to the Lake Superior ports for the purpose of building up a supply of twine against the harvesting season begins as early as January shows the importance of other factors than small savings in transportation charges.

movement would not require use of the St. Lawrence, nor would that from Mexico and Cuba. The remainder is of such small extent as to be negligible. Our imports of other cordage are of small extent. As they require a high grade of transportation service, none but the most "occasional" use of the St. Lawrence route can be foreseen.

A final word about Canada. Her exports of binder twine are very largely to the United States and her imports almost exclusively from there and hence have been disposed of above. The remainder of her exports are of such small extent as to be amply covered by the allowance of 1,500 tons made above. Canada's exports and imports of cordage are subject to the same transportation requirements as those of the United States. It is to be expected, therefore, that both the outgoing and incoming products will collect at Montreal, with only "occasional" use of the St. Lawrence waterway. This traffic in its entirety is, after all, a very small item.

VI. Hides and Skins

The questions to be considered in connection with this source of potential traffic are as follows:

First: Would the present eastbound traffic in hides and skins, which moves all-rail from Western packing centers to Eastern tanneries, be diverted to coastwise vessels were the St. Lawrence route developed?

Second: Would Middle Western tanneries import foreign hides and skins direct at Great Lakes points if an all-water route were available?

1. *Domestic hides and skins.* The supply of domestic hides and skins is derived largely from the big packing establishments and the small abattoirs and local butchers in the Mississippi Valley. The tanning industry is concentrated in the Northeastern industrial section of the United States, that is, the area east of the Mississippi and north of the Ohio Rivers. Hence, the general movement of hides and skins is east and northeast.

The New England and Middle Atlantic states receive over 225,000 tons of Western hides and skins annually.[9] Our first problem, then, is to consider the feasibility of developing an outbound coast-wise trade in hides and skins, were an all-water route available.

Hides and skins consigned to tanneries in western New York and Ohio would not use the St. Lawrence route. Our analysis of the geographic location of tanneries in the New England and Middle Atlantic states shows that these tanneries may be grouped into three regions: those in western Pennsylvania and western New York; those around Boston; and those along the New Jersey coast. The first group is scattered through Central Pennsylvania and the territory tributary to Buffalo.[10] These tanneries manufacture sole leather and utilize Western hides of the classes available at Chicago and Milwaukee markets (packers, steers, and cow hides). If there were any gain in using water transportation, therefore, we should find these tanneries shipping hides from Chicago to Ashtabula, Erie, and Buffalo, via the Great Lakes, thence by rail to their tanning plants. In no case would they ship hides past these lake ports, around to New York or Philadelphia and thence inland on a longer rail haul than they would have from Lake Erie ports direct.

[9] Based on figures compiled by the Tanners' Council of America showing movement of hides and skins in Official Classification territory and from points in other territories to points in Official Classification territory for the calendar year 1924. Tabulation covered tanneries representing 60 per cent of the annual consumption of cattle hides and 40 per cent of the consumption of calf, sheep, and goat skins. The Middle Atlantic states include New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia.

[10] The Pennsylvania plants of the Central Leather Company are located at the following points: East Stroudsburg, Emporium, Instanter, Irvona, Jameson City, Ludlow, Mann's Choice, Ralston, Ridgeway, Tunkhannock, and Wilcox.

The American Hide and Leather Company has tanneries in New York at the following points: Balston Spa, Buffalo, Little Falls, Portville, Salamanca, and a plant at Curwensville, Pa.

Some western hides would probably move coastwise to New England points. Large manufacturers of upper sheep leather and patent leather are located at Lowell, Lynn, Peabody, Woburn, and Salem, Massachusetts. These establishments use light cattle hides, calf skins, and sheep skins, all classes of which are available in Great Lakes territory. During the season of 1923 New England receipts of domestic hide and skin originating in Central Freight Association territory and Western Trunk Line territory were approximately 40,000 tons.[11] Of this total roughly 21,000 tons were bought in lake markets—Chicago (including Hammond, South Chicago, Calumet, and National Stock Yards of Illinois), Milwaukee, Detroit, Toledo, and Cleveland. Present rail rates on hides and skins moving in carload lots from Central Freight Association territory to New England are illustrated as follows: Chicago to Worcester, 59½ cents per 100 pounds or $11.90 per ton; Detroit to Manchester, N. H., 47 cents per 100 pounds or $9.40 per ton; Cleveland to Worcester, 43 cents or $8.60 per ton. Allowing as much as $1.50 or $2.00 per ton for handling hides between ship-side and tannery yards, it still remains likely that coast-wise vessels, if they were successful in establishing regular services at all between Great Lakes and Atlantic seaboard cities, would be able to offer shippers a rate on hides which would make the water route attractive. Taking into account the possibility of growth, we may allow 15,000 tons of domestic hides as the annual outbound traffic for shipment to New England via the St. Lawrence.

A third group of tanneries which use Western hides are the manufacturers of upholstery leather along the New Jersey seaboard. These plants use a heavy packer hide and might conceivably ship part of their requirements from Chicago by the water route. The New Jersey upholstery industry prob-

[11] Figures presented by Tanners' Council of America, *ibid.*

ably uses less than 12,000 tons of hides a year.[12] Six thousand tons would, therefore, be the maximum tonnage available for water transportation to New Jersey ports, assuming that this state's requirements of hides were met entirely by purchases made at lake points.

2. *Imported hides and skins.* Imported cattle hides and calf skins tanned in Great Lakes territory amount to not more than 22,000 tons per year. Figures compiled by the Tanners' Council showed a total movement of hides and skins into this region from all other regions of 108,000 tons for the year 1923. Of this total only 7,171 tons were imported stock, distributed as follows: cattle hides, 4,003 tons; calf and kip skins, 3,618 tons. On the basis of these figures we may therefore estimate the total consumption of imported cattle hides and calf skins in this territory for 1924 at 14,600 tons.[13] To allow for growth we will raise this figure to as great an extent as 50 per cent, giving a total of 22,000 tons per year as the maximum tonnage on which to make estimates of potential traffic for the St. Lawrence route.

The supply of hides and skins comes on the market in a fairly even flow throughout the year. Hence we have from 1,800 to 2,000 tons of hides and skins per month as the maxi-

[12] This estimate was made up as follows: Whole-hide grains and buffings entering into the manufacture of upholstery leather in the United States, as reported by the Census of Manufactures for 1923, were converted to tons on the basis of 68 pounds to the hide. New Jersey consumption was estimated at 60 per cent of the total on the basis of the Census of Manufactures for 1919, the last census reporting the production of classes of leather by states.

[13] Imports of sheep skins into Great Lakes territory are very small. Minnesota, Wisconsin, and Chicago each have one tannery handling sheep skins; Detroit has two tanneries which handle both calf and sheep skins. There are no tanneries in Ohio and Indiana which utilize sheep skins.

Practically no goat skins are tanned in the Middle West. Imports are used principally for fancy upper and glove leather and are tanned in plants located on the seaboard, almost the total volume of imported goat skins being worked up at Philadelphia, Camden, and Wilmington.

mum potential traffic for the St. Lawrence during the open season. These foreign hides and skins move into this country currently in small lots from all parts of the world—from 14 different trade regions including 65 different countries. Omitting stock received from the Argentine and from Brazilian ports, a check which we have made of incoming cargo for the first 15 days of July, 1927, showed 82 vessels arriving at New York with hide and skin consignments totaling 390 parcels.[14] The only hide imports that would conceivably move over the St. Lawrence route would be those coming from northern European countries, from which region alone general shipping services would be available. Moreover, they would consist of only those special grades and qualities[15] of materials which are not available in the interior of the United States. Still another factor working against the use of the St. Lawrence route is the fact that hides and skins are imported by East Coast dealers, who grade them at point of import prior to their distribution in small lots throughout the trade. The seasonal character of the St. Lawrence route would make the establishment of such grading and distributing centers on the Lakes quite impracticable. In this connection it should be recalled that since the bulk of the tanning industry is in the Northeastern part of the United States this leather would have to be

[14] Compiled from the New York *Journal of Commerce*. Imports from Brazil and the Argentine were omitted because the hides available there are very similar to United States packer hides and are used by Eastern tanners to supplement the inadequate supply of domestic hides.

[15] The uses of leather range from wrapping for golf club shafts and tobacco pouches to saddles and textile machinery equipment; the demands for raw materials vary accordingly.

The natural quality of a hide or skin varies with the climate in which the animal is raised, the food the animal is given, and the age at which it is killed. Considerable variation also appears between skns of animals raised under the same environment. The commercial value of the hide is determined by these natural qualities and by the flaying and preserving technique used in handling it. The by-product character of the hide and skin industry prevents the control of quality except to a very limited extent.

distributed from a lake city back to the East. Accordingly, we must conclude that the total of such potential traffic is so negligible as not to warrant inclusion in our traffic estimates.

It remains to inquire whether the route might not stimulate an expanding import trade in the future. The answer to this question is obvious. With the east-bound domestic movement of hides and skins now aggregating, as we have seen, 225,000 tons per year, there would be no economy in shipping a large volume of imported hides and skins past the Eastern markets of deficit production into the Middle West, which has a surplus production. Imports moving into Western markets must continue to be of special grades and qualities to meet special requirements rather than stocks for general tanning purposes.

VII. Rubber, Silk, Jute, Etc.

These materials are grouped together because all of them originate in the Far East, and present commercial problems of a common character. By the " Far East " we mean the British East Indies, the Dutch East Indies, French Indo-China, the Philippines, China, and Japan. Preliminary to a discussion of the possibility of importing the above commodities via the St. Lawrence, we must consider, first, the character of shipping services available between the United States and the Orient, and, second, the possibilities for export commerce between the Middle West and the Far East.

A. Character of Shipping in the Far Eastern Trade

Direct shipping services to the Orient are available from the North Atlantic coast ports, from New Orleans, from San Francisco, and from the Puget Sound ports. Characteristically, vessels trading in the Orient make a circuit of ports rather than two or three adjacent ports. The Dollar Steamship Line maintains an around-the-world service. Leaving New York the Dollar boats go west through the Panama Canal, thence north

via Honolulu to Yokohama. From Yokohama they head southward, skirting the coast of Asia, calling at Chinese and East Indian ports, thence sailing westward through the Suez. In the Mediterranean they call at Genoa, Naples, and Marseilles. From Marseilles they return to Boston, thence to New York. The Prince Line vessels make a similar circuit, also sailing westward around the globe. From Yokohama they go to Chinese ports, thence eastward to the Philippines. From the Philippines they drop down to Java, thence to Singapore, other Straits ports and westward to Boston, via the Suez Canal. The American and Manchurian Line steamers, homeward bound, leave Shanghai for Hong Kong, then call at the Philippines, Straits Settlement ports, and Colombo, the principal port of Ceylon. From Colombo they sail westward via the Suez to North Atlantic coast ports.

Vessels adapted to the Far Eastern trade are too large for the St. Lawrence route. To call attention to what is well known, the distances between North Atlantic ports and Far Eastern ports are much greater than the distances between other trade regions of the world. The distance from New York or from Liverpool to Shanghai is approximately 12,000 miles. The run from New York to Liverpool is 3,578 miles, only a little more than a fourth of the run from either of those ports to the metropolis of the Orient. Our closest contact with the Far East is Seattle to Yokohama, a distance of 5,000 miles. Vessels leaving Liverpool for the Far East must traverse a distance of 7,700 miles to reach Colombo, Ceylon, the most western port of the Orient. To make other comparisons, Shanghai to Singapore is approximately the same distance as New Orleans to Halifax, 2,545 miles, compared with 2,536 miles. Boats, therefore, making a round trip New York or Liverpool to a circuit of Far Eastern ports and return to home port travel some 25,000 to 30,000 miles.[16]

[16] Prince Line vessels travel roughly 25,000 nautical or 29,000 statute miles—New York to the Orient and return. Steaming distances in statute miles are as follows: New York to Panama,

It is obvious, therefore, that the maintenance of steamship services over such long routes is a very different problem from that of maintaining touring services over the New York to Cuba route for example, which involves a round trip of only 2,800 miles. The boat on the longer run must have much larger bunker supplies, and at best can make only a few trips a year. Also vessels engaged in the far Eastern trade must have relatively higher speeds than vessels employed on shorter runs, if commerce is to be carried on with the Orient under the general conditions of trade which prevail in the Western World. Satisfaction of these requirements means increased size of vessels both because of the gain in cubic content available for paying cargo which the larger vessel affords and because increase in the size is necessary if the speed is to be increased.

Consequently we find the prevailing type of vessel employed in the Far Eastern trade is one which would require a 33 foot or a 37 foot channel, and that practically none of the vessels maintaining services between New York or London and the Far East respectively could enter when loaded less than a 30-foot channel. Loaded drafts of Dollar Line vessels vary from 28 feet 10 inches to 32 feet 3 inches. Prince Line vessels employed in the Far Eastern trade have a draft of 27 feet, 6 inches.

Vessels employed in these Far Eastern trades spend about three and a half months on a round trip. Dollar Line vessels make the circuit of the globe on the schedule indicated above in three months and 13 or 14 days. Prince Line vessels take three months and 17 or 18 days for the round trip to the Far East.

2,323 miles; Panama to Yokohama, 8,960 miles; Yokohama to Kobe, 398 miles; Kobe to Shanghai, 898 miles; Shanghai to Hong Kong, 981 miles; Hong Kong to Manila, 727 miles; Manila to Cebu, P. I., 450 miles; Cebu to Batavia via Sourabaya and Semarang, 1,994 miles; Batavia to Penang via Singapore and Port Swettenham, 1,057 miles; Penang to Port Said, 5,511 miles; Port Said to Boston, 5,765 miles, Boston to New York, 435 miles. (Total of these figures, 29,499 miles.)

Since it is arguable, however, that the type of vessels employed in the Far Eastern trade might be modified somewhat to meet the need of the commerce available, we may turn our attention to the broader question involved, namely the character of the commerce between the United States and the Far East.

B. Exports to the Far East in Relation to the St. Lawrence Route

In discussing the exchange of goods which the United States now enjoys with the Orient and the possibility of handling part of that commerce through lake ports, it is significant to note the difference in point of view between waterway advocates and steamship operators. The first group, in discussing the traffic possibilities of the St. Lawrence route, will call attention to the volume and value of the resources of the Great Lakes region. The steamship operator considers primarily the competitive advantages of a trade region compared with other trade regions, that is, the variety of weight and measurement tonnages, both inbound and outbound, which a region can supply for overseas trade. In considering the feasibility, then, of developing waterborne trade between Great Lakes territory and the Far East we shall need to take into account the competitive position of the Great Lakes area with respect to both exports and imports.

Great Lakes ports could not compete advantageously with Gulf and Pacific ports for our export trade in raw materials and related products. The disadvantages of the Middle West in a contest for trade with the Orient may best be made clear by noting the strength of her competitors. First, we may note the area tributary to Gulf and South Atlantic ports. The Southern states have short staple cotton and naval stores, two classes of raw materials of very great importance in world markets, both in Asia and Europe. Second, with respect to three other commodities, tobacco, sulphur, and phosphate rock, the South is

in an exceedingly strong position. Sicily is her only competitor in supplying the world with sulphur; Morocco is her only competitor at the present time for commercial supplies of phosphate rock. With reference to two other essential classes of raw materials, soft wood lumber and petroleum products, the South is in an enviable position, and with reference to grain the position of her ports compares favorably with that of any other group of North American ports.

If we summarize these materials the list is imposing—four raw materials, cotton, petroleum products, lumber, and grain, supplying four primary needs of the world, and four other essential materials, namely, tobacco, sulphur, naval stores, and phosphate rock. With this group of commodities as a foundation for outward shipping, Southern ports are in a position to attract an increasing volume of iron and steel manufactures from the Alabama district and cotton textiles from the Carolinas.

We may now look at the Pacific Basin as a source of outbound commerce. Here we find no industries which can be considered practically the world's main source of supply of any one commodity, but we do find several industries in an extremely strong position. Pacific Coast lumber alone offers the Northern Pacific ports a solid foundation for building up outbound freights. California petroleum products provide a very satisfactory nucleus for building up outbound cargoes at the principal California ports. The Pacific fruit industries have no competitor in the United States or Canada so far as Far Eastern trade is concerned and only the Mediterranean region to watch as a foreign competitor. Arizona, Montana, and British Columbia supply the Far East with copper, zinc, and lead. Puget Sound and Alaska salmon fisheries supply the Occidental civilization of the Orient with an essential meat substitute. In addition to these industries, which are peculiarly West Coast industries, the Pacific Coast also produces coal (British Columbia), meat and meat products, cereals, and paper.

We may now look at Great Lakes territory in comparison with these regions. We find that the raw materials, and related products, which the Middle West produces are iron ore, coal, copper, zinc, and meat products. But iron ore obviously could not be shipped to the Orient in competition with Cuban or Chilean supplies. Vancouver and Hampton Roads offer closer coal supplies than Great Lakes ports. Copper and zinc, as noted, are available through West Coast ports. The territory tributary to the Great Lakes is the only United States source of linseed. Since, however, we are on an import basis, control of the domestic supply of this raw material is of no value to the Great Lakes from the standpoint of building up export trade. With respect to cereals and meat products, the unfavorable position of the Middle West for trade with the Orient is quite patent. The Asiatic countries are primarily dependent on rice as a staple breadstuff. Their requirements of wheat and wheat flour may be met by purchases from Australia, from the West Coast of the United States and Canada, or from Argentina. Small quantities of meat and dairy products may be purchased at Seattle and Portland. New Zealand is the logical source of supply for these products in any volume.

In summary then it may be noted that the territory tributary to the Great Lakes has no raw materials which would make lake cities ports of call on a basis comparable to that enjoyed by Gulf and Pacific ports.

Great Lakes ports could not compare favorably with North Atlantic coast ports for export trade to the Orient in manufactured goods. When we compare the classes of manufactured goods which would be available at Great Lakes ports for making up outbound cargoes for the Far Eastern trade with the varieties of manufactured products which could be easily assembled at North Atlantic coast ports, we find that the Eastern ports would have a competitive disadvantage. For certain classes of iron and steel products, such as agricultural implements, machine tools, automobiles and automobile accessories,

purchases if made in the United States presumably would be made in Great Lakes territory, and it might be argued that these industries would attract shipping to Great Lakes ports, such as Chicago, Detroit, and Cleveland. On the other hand it must be noted that North Atlantic seaboard plants and establishments in the Alabama steel districts would certainly bid for Eastern trade in many classes of manufactured iron and steel products. Likewise, Middle Western manufacturers of chemicals would have to compete with New Jersey plants for overseas trade.[17] With reference to other important manufacturing industries, such as producers of rubber goods, paints and varnishes, paper, pharmaceuticals and drugs, confectionery, and tin plate it may be noted that each class of products is manufactured both in the Middle Western states and in the North Atlantic states, and each uses imported raw materials. Of the imported raw materials entering into these several industries—crude rubber and latex, wood pulp and pulpwood, earth pigments, varnish gums and shellac, drugs, essential oils, cocoa, edible nuts, and tin—only the raw materials used in the paper industry could be brought into Great Lakes territory via the waterway on a favorable distance basis. Wood pulp and pulpwood are imported into this country principally from Canada and from Scandinavian countries.[18] Pulpwood imported from North European countries would traverse approximately equal distances in reaching Philadelphia or Detroit. All the other raw materials mentioned above are imported in the United States from areas southeast or southwest of North Atlantic ports and would have to be shipped inland past New York whether handled by rail or via the all-water route.

[17] Attention need only be called to the fact that many of the leading iron and steel companies, chemical and electric companies have plants located both in the Middle Western states and in the North Atlantic seaboard states.

[18] For discussion see Appendix D, Section II.

Considering export trade from the ship cargo standpoint, a factor of perhaps even more significance than those yet mentioned, is the lack of textile industries in the territory tributary to Great Lakes cities. Neither cotton, silk, or wool textiles would be available for making up cargoes of general merchandise at Great Lakes ports (except as they may have been shipped, from Eastern and Southern points of manufacture, westward). Nor would wool and fiber floor covering, linoleum, or cordage and manufactures of jute be available at lake ports.

In summary, then, we find from the standpoint of building up outbound freights to the Far East, the Great Lakes region lacks the variety of raw materials available through Gulf or Pacific ports, and would be at a serious disadvantage as compared with the North Atlantic coast in assembling export shipments of manufactured products. Her only products which might conceivably attract steamship lines for direct shipments of outbound freight to the Far East are her manufactures of iron and steel, agricultural implements, automobiles, and electrical goods.

C. United States Imports from the Far East in Relation to the St. Lawrence Route

In considering possible imports from the Far East via the St. Lawrence route, we shall discuss, first, the important commodities—rubber, silk, and jute, and then follow by an analysis of possible imports of a miscellaneous group of commodities. (Tin is discussed in Appendix G, Section III.)

1. *Rubber.* The importance of rubber to American industries today, and the concentration of automobile tire production in Ohio have naturally suggested the possibility that imported crude rubber might constitute a very important item of traffic on the St. Lawrence. Rubber comes largely from the Straits Settlement and the Dutch East Indies. Our conclusion is that the transportation cost constitutes too small a proportion of the final value of the product to make the question

of a slight possible reduction in transportation rates of any real importance. The freight rate on crude rubber in carload lots, New York to Akron, Ohio, is $9.40 per short ton. The New York spot price of plantation ribbed smoked sheets (October 1, 1927) is about $660 per short ton. The difference between the bid and asked price on this date was $5 a short ton, which it will be noted is more than one-half the rail freight charged for transporting rubber, New York to Akron. Taking into account the risk of price changes while en route, the additional insurance premiums and interest charges which would be involved if the St. Lawrence route were used, it is obvious that the dealers in rubber would not be interested in having it brought via the all-water route as far as Cleveland.

2. *Silk*. American imports of raw silk from the Orient are extensive, but they are brought across the Pacific to American and Canadian ports and thence rushed, sometimes in solid trains operated at express speed, to Eastern points. There is no possibility whatever of use being made of the St. Lawrence route for such traffic.

We import from Europe a considerable amount of silk waste, spun silk, and rayon, but the location of the American silk industry in the Eastern cities clearly precludes any use of the St. Lawrence route for these imports. We also import considerable amounts, from a value standpoint, of manufactures of silk and rayon from Europe, and some of such traffic might utilize the St. Lawrence. Such traffic would be of such slight proportions, however, as hardly to figure in a tonnage estimate.

3. *Jute and manufactures thereof*. Jute is used in the manufacture of material worked up into bags for coffee, sugar, etc., as wrapping for cotton, and foundation material for linoleum, asphalt roofing, etc. In 1927 our imports of jute and jute butts amounted to 92,415 tons. Practically the entire supply comes from British India and is of course brought in along with rubber and the other commodities originating in that general trade regions. Jute burlaps, bagging, and bags were imported in 1927 to the extent of 325,392 tons. They come in the main

from India, with Europe a secondary source of supply and a more important source of minor jute manufactures. Canada's imports of jute and jute products amounted in 1927 to approximately 30,000 tons, of which about one-sixth came from the United States. So far as jute and jute butts are concerned, the fact that the establishments engaged in the manufacture of jute products are located almost exclusively in states not adjacent to the Great Lakes definitely debars the St. Lawrence as a transportation route.

In the case of burlaps, bagging, and bags, the answer is more difficult. For the year 1927 as much as 19,000 tons entered at interior customs districts (Buffalo, Minnesota, Wisconsin, Chicago, Ohio). Could some of this traffic not be routed via the St. Lawrence? It is possible that some might move in on an occasional boat that would put into the Great Lakes region. The greater part would certainly be landed at our various ocean ports, owing to the much greater frequency of ship arrivals there, to the fact that shipments into the interior probably constitute less than 10 per cent of our total imports, and to the fact that other commodities such as rubber, which are imported along with jute, would continue to use seaboard ports. Allowing liberally for the expansion of imports of manufactures of jute, we may estimate the use of the St. Lawrence route at 40,000 tons per annum, of which about one-fifth would represent Canadian importations.[19]

4. *Miscellaneous imports.* Other commodities from the Far East that must be considered are sugar, crude copra, cocoanut oil, and manganese ore, which are adapted to tramp traffic; and the following, which may be regarded as potential cargo liner or passenger cargo traffic: pig iron, castor beans, goat skins, cotton, carpet wool, cocoanut oil meal cake, peanuts, and Chinese wood oil.

[19] Exports of burlaps, bags, etc., though fairly extensive, would require, in view of the location of both the United States and the Canadian industry, no use of the St. Lawrence route.

Philippine sugar could not compete with Cuban sugar in Great Lakes territory. Crude copra is imported at Pacific ports and at New York by vegetable oil mills located at those points. Cocoanut oil moves inbound to the United States ports in oil (petroleum) tankers which go outbound to the East, with cargoes of petroleum products either from California or from the North Atlantic coast ports. Manganese ore is well adapted to shipment in full cargoes; but it is not likely to move over the St. Lawrence, since ferro-manganese is not manufactured in the Chicago district. It may also be noted that the regular liners calling at Indian ports for other commodities bound for New York require manganese ore to round out their deadweight tonnage requirements.

The second group of commodities just mentioned would not, for trade reasons, be available for shipment in any quantity to interior points in the United States. Practically all of the goat skins used by United States tanners are made into fancy leather at seaboard points. The lack of textile industries in the Middle West would operate against the importation of cotton and wool at interior points. Likewise, the textile industries' requirements for castor oil will keep the castor bean presses near the Atlantic seaboard. Oil meal cake is used as stock feed and would not be imported into interior regions in competition with domestic feedstuffs. The Middle West importer of peanuts or human hair from China or of beans and egg albumen from Japan would scarcely find it practical to perfect arrangements for receiving such commodities six months out of each year at lake ports.

Chinese wood oil is a better possibility. It is used for making waterproof varnishes, and it might be argued that it would be imported directly at Chicago, Detroit, and Cleveland. There would, however, be involved the construction of storage tanks and pumping machinery for handling this oil at Great Lake ports; and during the season of closed navigation this equipment would have to remain idle.

To summarize: Commodities which are imported from the Far East and adapted to the tramp vessel, could not be marketed in Great Lakes territory in competition with nearer sources of supply, or they would not come in for some reason peculiar to the particular trade. The territory tributary to the Great Lakes has grain, coal, and iron ore to offer as outbound cargo, but these raw materials could not be sold in the Far East. When it comes to liner traffic possibilities, we find that the Middle West lacks essential raw materials for the outbound traffic, such as are available at Gulf and Pacific ports; and the inbound traffic is, for shipping reasons as well as for trade reasons, practically certain to be consigned to North Atlantic ports, principally New York. Moreover, the classes of vessels employed in the Far Eastern trades are generally too large to navigate the channels contemplated for the St. Lawrence.

VIII. Sundry Manufactures

Under this head are considered a group of manufactured articles of minor importance, which have been suggested at various times as potential traffic for the St. Lawrence.

1. *Toys.* Our imports of toys have recently been at the rate of about 10,000 tons per annum and have come almost wholly from Europe, the Far East supplying most of the rest. It is significant to note, however, that only 46 per cent of the 1924 imports passed through New York, while the secondary Atlantic ports, particularly Baltimore, accounted for nearly 25 per cent of the total, Gulf ports 6 per cent, Pacific ports 11 per cent, and interior customs districts 12 per cent. This wide scatter of points of import is characteristic of the types of traffic that have generally been found most likely to make some use of the St. Lawrence waterway.

To a large extent the scatter appears to be the result of the practices of those peculiar types of business organization—the five-and-ten cent store and the mail-order houses. The former,

for example, have their purchasing agents abroad, who assemble the toys from scattered local sources, make them up in assortments of various sizes, and dispatch them to the American ports from which they can be most cheaply sent to the individual local store. This is a type of traffic which can use slow service.

While the regular importers of toys would doubtless continue to use New York as the principal port of entry, it seems not impossible that the five-and-ten cent stores, the mail order houses in Chicago, and perhaps the large department stores in a few large lake cities could, if they would go to the necessary trouble and expense, route some of their toy shipments directly into the Lakes. Here, as in many other instances, the advantage in doing so would be a minimum at, let us say, Buffalo, increasing as water mileage is substituted for rail mileage until a maximum is reached at Chicago. It is doubtful, though, whether there would be any appreciable saving in such a routing over present ones in reaching points that would require a rail haul beyond lake ports, unless it be perhaps in reaching points in Wisconsin, Minnesota, the Dakotas, etc. Shipments through Baltimore, New York, and Gulf and Pacific ports limit the territory which could advantageously be reached through the Lakes.

Would it be advantageous to move the toys in before the close of navigation in November? The sale of toys is, of course, a seasonal one, having its peak in the Christmas shopping period. Where there would be some storage anyway this would not be a serious consideration and doubtless in most cases this would not be regarded as an important drawback. Any doubts on this subject will accordingly be waived.

If we start with the 10,000 tons of present imports, raise this 50 per cent to allow for growth of population and sales by 1940; and then deduct for shipments that, for the reasons stated, would continue to go through our various ocean ports, for shipments to the interior made by the regular importers, for some shipments during the closed season; and again note the rather limited territory in which there might be some advantage in

using vessel service direct into the Lakes, 2,000 tons of traffic available for the waterway would appear to be a very liberal estimate.

Canada receives about three-fifths of her toys from the United States. Her aggregate imports appear to be about 2,500 tons per annum. None of those from the United States would have occasion to use the St. Lawrence route. Production is preëminently in such Eastern states as New York and Massachusetts, and even from such states as Ohio and Illinois use of the route in reaching eastern Canadian points would not be justified. The water haul would be too short, and routing factors other than rates too important. If we assume that 500 tons of the remaining imports would move direct to interior Canadian points from abroad, we shall be distinctly liberal.

Our exports of toys have been at the rate of about 3,700 tons per annum recently, of which 44 per cent have gone to Canada and a large part of the remainder to Latin America and the Far East. In view of the predominance of the East, especially New York and Massachusetts, in toy production, and the character of service generally required on this type of export traffic, it does not appear at all possible to set down any figure to represent potential traffic for the waterway.

Canada's exports of toys, if any, are of extremely small amount and no use of the waterway is indicated.

The only "intercoastal" business of this character that is likely to develop would perhaps be a movement into the interior from a state like Massachusetts. The fact that the movement is a seasonal one and can therefore be planned for in advance, as well as the character of the buying organizations, makes possible some use of the infrequent packet service that is likely to be available between such points. Limitations are set by the necessity of transfers, the directness of the competitive rail hauls to the interior, and the seasonal closing of the water route. An allowance of 500 additional tons under the circumstances seems all that is called for.

2. *Athletic and sporting goods.* The story here is very much the same as that in the case of toys, and so can be very much abbreviated. Our imports of golf and other balls, fishing apparatus, etc., probably do not greatly exceed 1,000 tons per annum. There is again a wide scatter of points of import, except in the case of golf balls, 90 per cent of which moved through New York in 1924. Fishing rods are largely of Asiatic origin and use Pacific ports extensively. Articles of this character are not sold as extensively as toys in five-and-ten stores or mail-order houses; their importation is therefore correspondingly less centralized. There is also much less of a peak of sales. If we assume total annual importations of 2,500 tons by 1940 (a liberal rate of increase), 10 per cent, or 250 tons, might be traffic for the St. Lawrence waterway.

Canada's imports under this head have been included among toys.

Our exports of athletic and sporting goods have been around 1,650 tons recently. Canada has taken close to a half of these. For reasons heretofore given, none of our shipments to Canada is likely to require use of the waterway. The remaining exports are of such slight extent and wide scatter that, in view of the type of service required and location of points of production, no appreciable use is likely to be made of the waterway.

Canada apparently has no exports under this head.

Movements between our coasts and the interior require a better type of service than is likely to be available on the waterway.

3. *Pianos, organs, and other musical instruments.* We exported in 1927 some 18,000 pianos, largely to Australia and to the countries to the south of us, and some 1,700 organs and 145,000 phonographs, besides a great number and variety of other musical instruments. It would be surprising, despite the considerable production of these items in the Lakes region, if any but the most "occasional" use could be made of the St. Lawrence waterway. The piano manufacturers of the Chicago district now ship to Australia largely via San Francisco and

Vancouver, and to Mexico via Gulf ports. No use is made of the intercoastal service for shipments to the Pacific coast from the Middle West. The difference between a ten-day-all-rail service and a six-weeks' service via Baltimore largely tells the story. The manifest advantages of the numerous producers along the Eastern Coast, the need for rapidity of movement, and, in many cases, the unimportance of transportation charges as an item in routing, prompt the belief that no regular use could or would be made of the St. Lawrence waterway.

Much the same can be said of our imports of musical instruments. Imported pianos and organs come very largely from Canada and so would not be able to use the waterway. The remaining items come mainly from Europe, especially Germany. New York, is of course, the one large port of entry. This is distinctly not the type of traffic that could use inferior transportation service. However, it is not impossible that, at times, mercantile houses in the lake cities could arrange their importations so as to make use of the relatively infrequent vessel service likely to be available. Under the circumstances, an allowance of 500 tons per annum would be distinctly liberal.

Canada's imports are largely from the United States. Her exports are of some importance and a large number of her piano manufacturers are situated at points (particularly Toronto) where advantage could be taken of the waterway. An allowance of 200 tons (400 pianos or organs) would be very liberal.

This type of traffic would not, except perhaps to a slight extent, on an "occasional" basis, be attracted to the inferior packet service likely to be available between the interior of either country and its coasts.

4. *Stationery supplies.* Here our exports are much more important than our imports. Our exports of pencils, pens, and penholders go largely to Canada, Latin America and the Far East. This fact, together with the predominance of the East in production, the small size of the individual shipment, and

the need for a high grade of transportation service, makes use of the St. Lawrence out of the question. Our imports of these articles are not extensive and while some might be brought in direct by such organizations as the five-and-ten cent stores and mail-order houses, the amounts would be too trivial to require further consideration.

Our exports of ink, particularly printers' and lithographic ink, are a more important item of traffic, amounting to some 6,500 tons in recent years. Our largest markets are, however, in Latin America and the Far East, nearly 80 per cent of our 1924 exports going there. This fact, together with the outstanding importance of New York and New Jersey in ink production and the character of transportation service required by this kind of traffic, makes it altogether unlikely that any significant proportion of our total exports would ever make use of the St. Lawrence route.

Canada gets nearly all her imported ink from the United States and again no use of the St. Lawrence can be foreseen.

Canada exports no ink and the United States imports none.

" Intercoastal " movements of ink are wholly unlikely in view of the only meager saving there might be under the best conditions and the requirement of frequent, dependable, and fairly expeditious transportation service.

Much the same can be said of paste and mucilage, of which we have recently exported some 1,500 tons per annum, about a third going to Canada. Production is predominantly in the East (particularly New York and Massachusetts). Nearly five-sixths of our exports go to Canada, Latin America, and the Far East, and the traffic itself is of high enough grade to require frequent and dependable transportation service. No use of the St. Lawrence, except possibly a little on an " occasional " basis, is therefore foreseen.

We have no imports under this head. Canada's imports of glue are largely from the United States and England. To be liberal, we have set down 500 tons as Canada's maximum likely use of the waterway for her imports. Her exports of

glue and glue stock pass almost wholly into the United States and no use of the St. Lawrence is indicated.

The considerations governing " intercoastal " movements are the same as those set forth above in connection with ink.

None of our 175 tons of exports of typewriter ribbons, produced mainly in the East and going to a wide scatter of countries, could use the St. Lawrence route. The same conclusion is indicated in the case of our exports of paper clips, erasers, inkstands, and other miscellaneous office supplies, of which about 1,500 tons have been exported recently. These have had a wide scatter, move in small lots, and require expeditious and dependable service. Canada depends largely on the United States for her supplies of these products. None is imported by the United States. No use of any kind is seen for the waterway, except possibly a little on an " occasional " basis.

5. *Printed matter.* Our exports of books and pamphlets, maps, charts, sheet music, and other printed matter has amounted to nearly 35,000 tons in recent years. Canada, Latin America, and the Far East are our best markets. Except for shipments to Canada, New York is the predominant port of export. Clearly, this is a type of traffic which requires a high grade of transportation service and, moving in small lots, is unfitted for the infrequent vessel service likely to be available out of the Lakes. The leadership of the East in the production of printed matter further confirms the conclusion that no use, except perhaps a slight one on an " occasional " basis, would be made of the proposed waterway.

Our imports under this head have been at the rate of about 4,000 tons per annum recently. Here also the service requirements and trade practices are such as to render impossible any but the most infrequent use of the waterway.

The foregoing applies to Canada as well as to the United States.

6. *Cameras and optical goods.* Without going into much detail, the salient facts which militate against use of the St.

Lawrence route for exports of this character are the predominance of production in the East (New York alone accounting for about 90 per cent of the output of photographic goods) and the high class of transportation service required. No allowance can be made under this head. The same can be said of imports and of any "intercoastal" movements, as well as of any Canadian movements. A wholly different and better type of service is required than would likely be available. A small amount of goods of this character might be brought in directly in the manner indicated in the case of toys and sporting goods, but the volume of such traffic would be negligible.

7. *Surgical and scientific instruments, dental supplies, etc.* Here again the indications are that the waterway would be unable to render the fast, adaptable, and definite service this class of traffic requires. Transportation rates here, as in the case of many of the items discussed above, are not an important factor in routing. No use of the water route by either the United States or Canada is indicated, except perhaps some very small shipments received by some of the big business houses in Chicago incident to other shipments from the same points of origin. The amounts would be exceedingly small.

8. *Roofing.* Slate and other roofing are treated elsewhere. Here reference is to composition roofing (asphalt, asbestos, etc.) and roofing preparations. Our exports of these products are not large and our best markets are in Latin America. Production is about evenly divided between the Middle West and all other regions combined. The export trade would be limited to the larger companies and these have plants at widely scattered points. One company has 30 plants in the United States and 7 in Canada. To save an unnecessary movement of raw material (much of which is of a coal-tar or petroleum origin) and to save on the movement of the finished product, exports would doubtless originate almost wholly in plants on or near the Coasts—Atlantic, Gulf, and Pacific. Here also the type of transportation service required would be available and there

would be no seasonal factor to contend with. For all these reasons no appreciable use of the waterway can be foreseen.

The United States imports none of these products. Domestic movements, with plants so scattered as they are, would not afford opportunity for use of the waterway.

Canada's exports appear to be limited to asbestos roofing, which at best are small and originate principally at Montreal, a point near the production of the crude asbestos. Imports are small and come mainly from the United States. No use of the waterway can be foreseen.

9. *All other miscellaneous.* Here are gathered together a great number of articles—lighting appliances other than electric, refrigerators, and fireless cookers, fire extinguishers, brushes, etc.—of which our exports, in the aggregate, probably do not exceed, at the outside, 12,000 tons per annum. This is traffic requiring from good to the best transportation service, and usually moves in small lots. Our markets are scattered and for the most part are in Latin America and the Far East, regions least easily reached via the St. Lawrence. Canada is an important market for some of the products. In some instances production is predominantly in the East. When all these factors and the effects of the closed season and of established marketing arrangements are considered, it can be seen that use of the St. Lawrence route would be of very limited extent. Some refrigerators, lanterns, etc., might move by such a route, partly on a regular and partly on an " occasional " basis. All in all, it would be distinctly liberal to put down, including an allowance for growth of exports, 3,000 tons of regular traffic per annum. This figure is large enough to compensate for any underestimate or omissions elsewhere in the general group of miscellaneous products.

Imports of a miscellaneous character include beads and buttons, bristles and brushes, art works, matches, pipes, etc. These have averaged perhaps 20,000 tons recently. Europe is the largest source of supply, with the Far East important in some

cases (as with bristles and brushes). New York is generally favored as the port of entry. Articles originating in the Far East would not move directly into the Great Lakes region, because of the unlikelihood that direct vessel service would be available. Such imports would be deposited at Atlantic or Pacific ports and move by rail from there. Some of the products, of European origin, are such as could move directly into the Lakes if service were available. The large mercantile establishments in the Middle West possibly could bring in some of their imports direct, as we have seen they could do in the case of textiles and other articles. Such use and any other direct importations might, under the most favorable circumstances, reach 2,500 tons per annum. This figure allows for growth of imports and is large enough to compensate for underestimates or omissions elsewhere.

No "intercoastal" movement of these articles can be foreseen.

While Canadian statistics are not on a comparable basis, we can set down, under a miscellaneous group of traffic, 1,000 tons of exports and perhaps 2,500 tons of imports. These figures are liberal enough to allow for growth and to make up for understatements or omissions elsewhere.

APPENDIX J

IMPORTED FOOD PRODUCTS

I. Sugar

The United States territory adjacent to the Great Lakes consumes sugar derived from four sources: (1) Local beet sugar, (2) Hawaiian and Philippine cane, (3) Louisiana cane, and (4) Cuban and Porto Rican cane. In addition to the beet sugar, it is estimated that the consumption in the states of Illinois, Wisconsin, Minnesota, Michigan, Indiana, and Ohio is 1,243,000 tons. Consumption of cane sugar in these states as of 1940 is estimated at 1,500,000 tons.[1]

Under the present organization of the industry, raw sugar from Cuba moves in liners or chartered vessels to refineries located at north Atlantic coast ports—New York, Philadelphia, and Boston. Some of the Cuban sugar also moves in by way of New Orleans. From these coast cities the refined product is distributed in carload lots to wholesalers and dealers. A study of the industry shows that the distribution of refined sugar is conducted on a highly competitive basis, trading being done on a narrow margin, and that the question of freight rates would

[1] The present apparent consumption of sugar for these states has been obtained by multiplying their estimated populations as of June 30, 1927, by a three-year average (1926-1924) of the per capita consumption of sugar for the United States as a whole. From these totals the beet sugar production (of these states) has been subtracted to obtain an approximate figure of the amount of sugar brought into these states from other regions.

To estimate the consumption of sugar in these states by 1940 it has been assumed that their average annual increase in population for the period 1928-1940 will be the same as the Census Bureau has estimated it to be for the period 1920-1928; and that the average consumption per capita of sugar will not increase. An allowance is also made for an increase in beet sugar production in these states.

be a determining factor in adapting trade to the water route. Advocates of the St. Lawrence have suggested two traffic possibilities.

First, it has been assumed that dealers at Great Lakes cities such as Chicago, Milwaukee, and Detroit would import refined sugar in full cargoes from refineries located at North Atlantic coast ports, via the Atlantic, the St. Lawrence, and the Great Lakes.

Second, it has been suggested that beet sugar refineries located in Great Lakes territory would import raw cane sugar directly from Cuban ports via the water route for refining during their slack season.

A. Refined Cane Sugar as a Source of Inbound Traffic

Hawaiian sugar and Louisiana sugar would clearly not find it advantageous to use the St. Lawrence route. The distance handicap is decisive even as against rail rates; and there is also the possibility of utilizing the Mississippi waterway.

With reference to sugar sent west from Atlantic coast refineries to Lakes cities the situation is considerably different. The rail rate on sugar from New York to Chicago is \$11.30 a ton. The steamer rate from Havana to Montreal is about \$4.00 a ton. The distance from New York to Chicago via the proposed St. Lawrence route is approximately the same as the distance from Havana to Montreal. If the water rate from New York to Chicago were the same per mile as the water rate from Havana to Montreal, the cost of moving sugar from refineries to Chicago would be \$4.00 per ton.

But, it is also necessary to take account of the fact that the St. Lawrence would require slower speed and would involve increased hazards because of the restricted character of its channels. Hence, it is essential to make some additional allowance in the rate for the physical disadvantages of the route compared with the high seas. As a minimum, we may add only

$1.00 for this handicap. We have then an estimate of $5.00 per ton as the minimum cost of transporting sugar from New York to Chicago over the St. Lawrence route.

In addition to paying freight on transportation of the sugar via the water route, however, a Chicago or Duluth dealer would also have to pay for insurance during the trip and haulage charges for transferring the cargo from shipside to warehouse. At least $1.00 per ton would be necessary to cover these additional expenses. This would bring our estimate of handling sugar over the water route up to $6.00 per ton compared with $11.30 to Chicago via rail transportation. In any event, taking railroad rates as they stand at present, it appears there would be a substantial differential in favor of the waterway clearly sufficient to compensate for the longer time involved via the water route. We conclude, therefore, that during the season of open navigation sugar would move from refineries on the Atlantic coast to Chicago and other upper lake ports, by way of the St. Lawrence.

To cities on the lower Lakes the case is not so clear. The railroad rate from New York to Cleveland is only $8.00 per ton and to Buffalo $6.40. The water distance from New York to Chicago is only a little over three times the rail distance. The water distance via the St. Lawrence from New York to Buffalo is 2,070 miles, five times the rail distance, and to Cleveland approximately four times. We are inclined to believe, therefore, that a considerable part of the sugar movement from the Atlantic coast refineries to western New York and to Ohio would continue to move by rail and, perhaps to a limited extent by the New York Barge Canal.

Taking, then, 1,500,000 tons as the amount of cane sugar imported into the above states, let us see what proportion might use the St. Lawrence waterway. While no precise figures for the movement from Hawaiian sources into this territory can be given, we shall assume that some Hawaiian sugar must continue to be marketed in this area. To allow for this move-

ment, we may reduce our estimate from 1,500,000 to 1,300,000 tons. In the next place it must be noted that the advantages of the water route would be greatest at lake cities. Indianapolis, Indiana, Columbus, Ohio, Springfield, Illinois, would certainly not receive all of their sugar by way of the Great Lakes since the cost of the rail haul from a lake port to such cities as these would doubtless absorb a considerable part of the differential between the all-rail and the all-water rates; and it seems quite improbable that cities back 350 to 400 miles from lake ports as, for example, Cincinnati and Evansville would receive any sugar via the water route. Because of these facts we may reduce the above total by 400,000 tons (roughly one-third), leaving 900,000 tons per annum as our estimate of the amount of cane sugar which will be consumed in or close to lake cities by 1940. Allowing finally for the closed season of navigation, we have something like 450,000 tons as our estimate of the refined sugar movement which would probably utilize the St. Lawrence route.

B. Imports of Raw Cane Sugar

Witnesses appearing before the International Joint Commission [2] more or less tacitly assumed that all of the beet sugar mills of the states bordering on the Lakes would engage in refining cane sugar were the St. Lawrence deep waterway available to ocean vessels. Relatively few of these beet sugar factories, however, are located on the water front. Of five factories in Ohio, only one, that at Toledo, is on the lake shore. Indiana has one inland factory. Minnesota has one beet sugar factory in the southern part of the state. All of the Wisconsin factories, five in number, except the one at Green Bay are in the interior. Illinois has one mill located at Riverdale, some distance from the South Chicago harbor. Michigan, which is the most important area of sugar beet production in the Lakes region, has

[2] This Commission held hearings on the St. Lawrence waterway in 1920.

less than one-half her total capacity represented in plants with lake frontage. Of a total daily slicing capacity of 16,100 tons, 8,850 tons are represented by mills scattered over seven counties in the southeastern part of the state. One small mill of 500 tons daily capacity is located at Holland on the Lake Michigan side; one is located on the peninsula, at Menominee. The remainder of the Michigan mills are concentrated around the upper end of Saginaw Bay. Three mills at Bay City, one further up the river at Carrollton, and one on the east side of the Bay at Sebewaing, representing a total daily slicing capacity of 5,550 tons, thus make up practically the only concentrated section of the beet sugar industry in the Lakes region. It would seem, therefore, that so far as mills now in existence are concerned, these Saginaw Bay mills are the only ones that would be sufficiently favorably located to make a bid for any volume of raw cane sugar for refining purposes.

The argument might be advanced that the beet sugar mills could afford to relocate at lake ports. The character of the industry, however, makes this seem quite improbable. In the case of beet sugar production, the extraction of the sugar is an integral part of the beet growing industry. Operations are based on contracts drawn between beet growers and factory owners. These contracts assure a minimum of beets to the factory, guarantee a minimum price to the farmers, and provide for participation by both parties in any extra margin of profit. Beets are hauled by wagon direct to the factory or are collected at railway receiving stations maintained by the factory. Beets must be kept moving into the factory or protected against adverse weather conditions. Approximately 12 per cent of the weight of the beets is recovered in sugar.

Relocation of beet sugar factories would, therefore, involve additional loading facilities for transporting beets over a larger area, possibly more local storage facilities and a longer haul on raw beets which would be uneconomical comparing tonnage of beets with percentage of sugar recovered. Moreover, the

beet pulp which is used for stock feed would be subject to a longer haul to place it in agricultural areas again.

Considering next the seasonal element, we find the beet sugar mills (other than those in California) start operating in October and run approximately 90 days, thus finishing up about the first of the year. It is thus clear that the beet sugar factories could handle raw cane advantageously only for the remaining nine months of the year, that is, January through September.

We may turn now to examine briefly the cane sugar industry. The United States at the present time obtains from 17 to 23 per cent of her sugar from her beet industry; 5½ per cent from Louisiana and Texas cane, and the remainder from Cuba and our insular possessions. The imported sugar, both domestic and foreign, is refined in 22 large refineries, all of which are located on the seaboard. These mills represent a total daily melting capacity of 48 million pounds. Two mills are located in California, one in Texas, one in Georgia, four in Louisiana. These handle the Pacific Coast and Gulf imports and make up a total of 25 per cent of the capacity. The other 75 per cent is represented by Atlantic Coast mills between Boston and Philadelphia. Forty-five per cent of the total capacity of the United States is located in the New York harbor district alone. This fact coupled with the further fact that the bulk of the imports of raw cane come from Cuba make the concentration of the sugar refining industry apparent.

Operations in these refineries are carried on practically the year round. The Atlantic Coast mills not only supply a very considerable part of the domestic market, but also engage in refining for export. In 1920, they exported 462,000 tons of refined sugar; in 1921, 467,000 tons; ; and in 1922, 918,000 tons.

Now the only time when conditions would be favorable for the Michigan sugar beet factories to secure a part of the raw sugar for refining would be during the peak of the Cuban cane production. When we look at the Cuban industry, however, we

find that the new cane crop starts coming into the local crushing mills the last of December or the first of January. The big movement is from then on until approximately June 1, when the rainy season normally sets in and greatly retards hauling. It is during this first six months that imports are heaviest. In 1919 imports for the first five months were 251,000 tons compared with 191,000 tons for the last seven months. In 1921 they were 276,000 tons for the first five months against 126,600 for the last seven, and in 1922 they were 345,800 tons against 277,000.

It will thus be seen that the peak of the raw cane import comes at the very time when the St. Lawrence route would be closed to navigation. It seems unlikely, therefore, that these Michigan beet sugar factories could stand the expense of changing their equipment for cane sugar refining for five or six months of the year and then change it back for handling beet sugar the last three months.

Some statements were made before the International Joint Commission as to plans for refining cane in Michigan beet sugar mills, and some experimenting along this line took place in 1920. Looking back on the year 1920, however, it is obvious that no arguments can be made on the basis of events in the sugar industry that year. Normal channels of sugar distribution were changed completely. Under the influence of rising prices, an unrestricted domestic market and the belief in an acute world shortage of sugar, sugar moved into the United States from the four corners of the earth. For the week of April 22, 1920, Willett & Gray reported the following:

"Among the countries that have shipped or resold sugar to this country are Java, China, Japan, South Africa, Formosa, Brazil, Peru, Argentine, Philippine Islands, and practically every Central American country; Spain, Holland, Sweden, Belgium, and Czechoslovakia."[3]

[3] Willett & Gray, *Weekly Statistical Sugar Trade Journal,* April 22, 1920, p. 204.

Obviously, any conclusions based on such abnormal conditions can have no weight as applied to the long-time tendency of the beet sugar industry.

As to the possibility of new cane mills being located in the Lakes region to meet the expanding requirements coördinate with the growth of the country, the closed season on the Great Lakes would preclude against any such development. The Eastern refineries are equipped to run the year around and have access to both foreign and domestic markets. New York is 1,366 miles from Havana. Sugar mills locating at either Cleveland or Detroit would add over 2,200 miles to the distance they had to transport their raw material or an increase of approximately 150 per cent. If they could build up a year around industry with rates on raw sugar New York to Detroit very much cheaper than the present rail rates on refined to this point, it might be assumed that one of the Eastern plants would locate a mill in this territory. With an open season of six to seven months, there is no reason for believing the opening of a St. Lawrence deep waterway would cause any of the cane sugar refineries to relocate in the interior.

C. Canadian Imports of Raw Cane Sugar

Canada produces some beet sugar, but derives most of her sugar supply from imported cane. Her sugar refineries are located at the following places: Dartmouth, Nova Scotia; Vancouver, British Columbia; Montreal; and Wallaceburg and Chatham, Ontario. The location of these refineries makes it obvious that any use of the St. Lawrence waterway for importing raw cane sugar would be limited to the refineries in Ontario.

The Dominion Sugar Company (owners of the Wallaceburg and Chatham refineries) produces both beet sugar and refined cane sugar.[4] This company starts refining raw cane sugar

[4] Information on the trade practices of the Dominion Sugar Company obtained through courtesy of its officers

in February and continues throughout the spring and summer. Imports of raw cane sugar are brought in from the Caribbean area via several routes: (1) ocean vessels to Montreal and rail to refineries; (2) ocean vessels to New York and rail to refineries; and (3) ocean vessels to New York, and New York Canal barges to refineries. An all-water movement of raw sugar from Caribbean ports to Wallaceburg has also been tried out. This Company reports, however, that it is difficult to get ocean boats small enough to navigate the Welland Canal (14-foot depth) and still carry cargoes of sufficient size to make the trade remunerative to the vessel owners. The volume of raw sugar imported by the Dominion Sugar Company varies from 40,000 to 60,000 long tons annually. About one-half of this movement comes in over the water routes.

It seems probable that the St. Lawrence route would prove a real advantage to the Dominion Sugar Company. Although this company does not believe that it would be practicable to build up a supply of raw cane sugar to use during the season when the St. Lawrence route would be closed, it does think that the water route would permit it to increase materially the volume of its raw cane imports during the open season. To allow liberally for the growth of this Company's business, we may assume that its import requirements of raw cane sugar for 1940 will average 75,000 short tons annually and that perhaps 50,000 tons of this movement will be potential traffic for the St. Lawrence route.

II. Coffee

Our imports of coffee in 1926 and 1927 amounted to about 732,000 tons as compared with a pre-war average of 450,000 tons. Our consumption per capita in 1927 reached approximately 12 pounds. Canada's imports in 1923 and 1924 averaged only about 11,500 tons, her per capita consumption in 1927 being only 2.67 pounds. In recent years about 85 per cent of

the coffee imports of the United States have come from South America, principally Brazil, 12 per cent from Mexico, Central America, and the West Indies, and only a negligible amount from the Far East.[5] This coffee moved into the country principally via New York (50 per cent) and New Orleans (29 per cent). Smaller amounts entered via San Francisco, Boston, Baltimore and other customs districts. In 1927 San Francisco received 9 per cent of our total imports as compared with 5 per cent in 1913-1914, a development undoubtedly largely due to the opening of the Panama Canal.

New York has traditionally been the one important American coffee market. Here is found one of the world's three most important coffee exchanges, with all the attendant importing, brokerage, sales, and shipping facilities. In the past, both large and small roasters have looked to New York for their supplies of green coffee. Inspection was afforded, spot supplies were carried from which immediate deliveries could be made, and the roaster could be accommodated with shipments of small size, made up of various grades of coffee to suit his needs.[6] All these functions the New York coffee market has performed for many years, though more recently, as indicated above, it has felt the effects of the competition of New Orleans and San Francisco and, to a certain extent, the threatened competition of a nearby port like Baltimore.

Handling and shipping charges on coffee—stevedoring, weighing, cartage, storage, assembling various grades from scattered

[5] Canada imports most of her coffee direct from producing country.

[6] It is important to bear in mind that the coffee we use is blended. The large roasters zealously guard their formulæ governing the proportions in which they mix different kinds of coffee. The small roaster, who is usually without an expert blender, depends on the import house from which he is accustomed to buy not only for the maintenance of the standard on each constituent coffee but in sending him, either mixed or in separate bags, the desired proportions of the various coffees. Inspection is chiefly important in the case of the higher grades of coffee.

warehouses, etc.—have greatly increased at New York and are felt to be burdensome. Delivery time also is regarded by some as unsatisfactory; it commonly takes two days after an order is received to get a shipment under way. To meet these criticisms the New York coffee industry has endeavored to simplify and expedite matters, though apparently not with complete success as yet.

It is becoming increasingly the practice for the large roasters to buy their coffee—or a large part of it—direct, either through their own representatives at the plantations or through brokers in this country. In recent years this tendency has extended in some degree even to the smaller roaster, for whom shipping agencies at the export point bunch or assemble and otherwise take care of shipments. The significance of this practice of buying direct is, from our point of view, simply that it puts the routing of inbound shipments strictly on a "transportation" basis, with the usual "marketing" considerations of little or no importance. This practice tends, therefore, to clear away one important obstacle to the use of the St. Lawrence route for bringing in supplies of green coffee. To obtain the proper emphasis, however, we should think of this practice as being primarily one in which only the large roaster can engage.

The final picture we should get is, then, about this: (1) the large roaster buys a large part of his coffee direct and routes it in via such gateway and rail route as affords the maximum transportation saving; time in transit is not as important a consideration as in the case of some commodities, owing to the fact that the large roaster will have considerable coffee in storage. (2) The large roaster also buys coffee from spot supplies in the coffee markets, principally New York, for which delivery time may or may not be important, depending on circumstances. Where time is not important, frequently one of the differential routes is used for the saving of three or four cents a hundred, or thereabouts, it affords. (3) The small roaster typically depends on New York (or one of our other

important markets), for the reason that he needs the technical assistance there provided and to be able to command a variety of grades on short notice.

Before endeavoring to ascertain whether the route would effect savings for these buyers, we should endeavor to establish whether or not a coffee " market " (in the sense of an exchange with all the attendant agents and facilities) would be likely to develop in the Great Lakes territory.

There appears to be two reasons why a Great Lakes " coffee market " is not likely to develop. First, no market could exist on a seasonal basis, which would necessitate either carrying large supplies over the winter months or withdrawing entirely from the business during the season of closed navigation. Second, no one place stands out as a convenient distributing point. Cleveland is too far east, Toledo too small, and Chicago would require a back haul to reach the consuming territory of greatest importance. Without pursuing the thought further, it seems wholly improbable that there would be an important coffee market in the Middle West.

Such being the case, it is clear that the small roaster, in so far as he does not buy direct, cannot get the coffee and the attendant services he requires anywhere except at the big coast markets, and shipments from there are made in too small amounts and require too prompt delivery to permit of use of the roundabout water route. But, it may be asked, would he not bring his direct purchases in via the St. Lawrence? This is remotely possible, but only in the case of roasters situated in the important lake ports and on the assumption of a saving in transportation charges. It is our belief that the small roaster, who cannot afford to spend a great amount of time and effort in effecting small reductions in transportation charges, will leave the routing to the assembling agent at the ports of origin. The latter, desiring to get shipments under way promptly, will generally use the boats making for New York and New Orleans, which will be many times as numerous as those that might ply

between the coffee ports and the Great Lakes. Should, therefore, some use be made of the latter boats, it would be on that "occasional" basis which would not entitle such traffic to a place in our estimates. In any event, the amount of coffee that might thus move would be extremely small.

Next, could the large roaster save money by using the St. Lawrence route for bringing in either the purchases made in the New York market or those made direct at the plantations? Most of the purchases which the large roaster would make in the New York market would be of special grades of coffee or of grades he commonly uses, but on which his stock is running low. In either case shipments would be in relatively small lots and prompt delivery would be required. It is altogether likely that little coffee that once got into New York warehouses would find its way into the interior by the time-consuming infrequent packet service that might be available into and from the Great Lakes. Certainly any use that might be made of such service would be limited to roasters directly at the important lake ports and their use would be so irregular as practically to stamp itself as "occasional." In judging this conclusion it must be borne in mind that it refers to the relatively small and irregular purchases of coffee made in New York by the large interior roaster. Of much more importance is the routing into the interior of purchases made direct at the plantations.

This case differs from the direct purchases of the small roaster in that there is more opportunity to plan matters of routing and a larger base over which to spread small unit savings in transportation charges. Coffee shipments into the Lakes could not, of course, be made in anything approaching cargo lots, unless perhaps a number of roasters in that region could get together and pool cargo shipments. With the large roasters spread out over a number of important lake cities, not to mention other difficulties, it does not appear likely that such pool cargoes would be possible. Our question becomes, therefore, one of determining what possible savings there would be

in using the infrequent and somewhat irregular general vessel service likely to be available between the Great Lakes and the east coast of South America.

The standard rail rate on green coffee from New York to Chicago, for example, in carload lots is 56.5 cents a hundred (75.5 cents L. C. L.), with differential routes offering rates from 2 to 7 cents per hundred lower. How much of this rate could be saved by a direct shipment into the Lakes? The rate from Brazil to New York has been recently 40 cents a bag or about 30 cents a hundred. To extend the haul from New York clear around into the Lakes, with numerous stops, would probably require a hundred per cent advance over the New York rate. It must be borne in mind that the trip from Brazil to New York requires no stops en route, permits of a quick turn around, involves no restricted navigation, and carries greater assurance of a return cargo, advantages which could not be retained were the vessels to put around into the Lakes. The total rate, Brazil to Chicago, would then be 60 cents all-water as compared with 86.5 cents via New York and standard all-rail to Chicago and as low as 81.5 cents via differential lake-and-rail. The maximum difference would be 26.5 cents and the minimum 21.5 cents. But this is not net, for out of this margin would have to be absorbed an expensive local trucking haul from public dock to private warehouse, which could not be less than 5 cents a hundred pounds. A small reduction must also be made because of extra insurance clauses for the water route. At least another 7 cents a hundred should be added under this head and for handling costs, leaving therefore net savings of from 14.5 to 9.5 cents per hundred pounds. The average savings, as compared with present routes, would perhaps be something like 15 cents a hundredweight. Since a very large part of the coffee moves in via the differential routes, we shall be liberal if we base our subsequent calculations on a net saving of, let us say, 11.5 cents per hundred. It should be particularly noted, however, that this differential would apply only on shipments to roasters directly at or within easy trucking distance

of the principal lake ports.[7] There is, moreover, another very important limitation which must not be overlooked.

The discussion above was on the basis of Chicago. We must now define the limits within which the differential indicated might apply. It would apply to Milwaukee and might conceivably be a little larger there. It would hardly apply to Duluth, for vessels serving Chicago would not also enter Lake Superior. Would other ocean-going vessels render service there? It is much more likely that general cargo from South America would have to be transshipped at some point, possibly Buffalo, for delivery to the head of the Lakes. Such a transfer would practically mean the addition of the total lake charge to the" ocean " rate, since the latter would presumably be the same to all the lake ports reached by the transoceanic liners. If such were the case there would be no advantage over routing via New York and thence rail-and-lake. Coming down to Detroit and Toledo, we find the standard rail rate from New York 46 cents and that from New York to Cleveland 40 cents. If we leave the " ocean " rate to these cities at 60 cents a hundred, the differential under the rate via New York would be from 16 to 11 cents in the case of Toledo and Detroit and from 10 to 5 cents in the case of Cleveland. Obviously, there would be no advantage in such cities using the all-water route after paying for the local truck haul and the other expenses indicated above.

This conclusion apparently puts us in the dilemma of saying that coffee might move direct from Latin America to Chicago and Milwaukee, but not to Detroit, Toledo, Cleveland, Buffalo, etc., though the boats carrying coffee would put in at least some of these places to discharge cargo. This in itself would not be impossible. For example, packet boats plying between Buffalo

[7] How expensive a local switching charge would be is shown in the fact that one large firm in an important lake city has its coffee brought in from the coast by a differential lake-and-rail route, deposited at a port some distance short of destination and there given to a carrier which, receiving a line haul, will place the cars directly at the doors of the coffee merchant's warehouse.

and Duluth carry relatively little traffic to Cleveland and Detroit, though these are regular points of stop. The reason is simply that there must be enough of a differential under the rates by alternative rail routings to compensate for the various drawbacks in using a seasonal and not well articulated water service. The other way out of the dilemma seems, in this case, even more pertinent. What are boats that plan to give liner service between the Great Lakes and Latin America going to bring in? Our studies of the movement of sugar, wood, hides and wool, nitrates, etc., show that in many cases there would be no appreciable movement into the Lakes and in other cases at best only intermittent service of an irregular character. Our analysis with respect to coffee strengthens this conviction, for coffee could contribute little to the maintenance of a profitable liner service.

Certain further factors appear also to put limitations on the direct importation of coffee via the St. Lawrence. More and more coffee is likely to move into the Middle West via New Orleans. The facilities for handling coffee there are becoming more extensive and with the standard rail rates into the interior being reduced to build up New Orleans and the differential rates available on the Mississippi-Warrior River barge line service, there is every reason to expect a greater movement up from the Gulf. Certainly if the improvements to the Mississippi and its tributaries now being advocated by some were put through, there would be less opportunity for the St. Lawrence route to be of service.

A second limitation is found in the fact that the large coffee houses with branches in the interior have their headquarters at New York, Boston, etc. These concerns now find it advantageous to bring in their large purchases there for distribution, often by the differential routes, to their various plants throughout the country. The advantages accruing from this practice are an important offset to any that may be found in moving the supplies directly inland.

Our general conclusion is, then, that only relatively small amounts of coffee would move directly to Lakes cities by water. The eastern Lakes cities would tend to use principally New York, as at present, and various factors detract from an extensive use of the route in bringing supplies to Chicago and Milwaukee. With boats plying intermittently between the Lakes and Latin America, there undoubtedly would be some coffee aboard on their return trip. The difficulty is in estimating the amount that might so move and in characterizing such traffic. Would it merely be "occasional" and therefore not entitled to a place in our final estimates, or would it become more of an integral part of the operations of interior coffee roasting establishments? To be liberal we shall include movements to Chicago and Milwaukee in our final estimates, for here some adaptation of present practices to the new facilities might occur. We do not believe, however, that such use would exceed 50,000 tons per annum. This figure is derived as follows.

Our total imports of coffee, assuming a per capita consumption of 13 pounds and that the population of the United States and of the lakes states will increase at the rate it has in recent years, may be set down in 1940 at about 850,000 tons. Deducting at least a third for the coffee used by the small roaster[8] leaves 566,000 tons. This must in turn be very seriously diminished to take account of movements that would continue to take place through New York, New Orleans, Boston, etc., movements to interior points back from the Lakes, and a considerable part of the coffee which would move during the closed season. At intervals boats would put into the Lakes having coffee abroad, with Chicago as the principal destination. As much as 50,000 tons of traffic per annum might, by liberal interpretation, be credited to the route under this head. This amounts to over 750,000 bags and represents nearly one-tenth

[8] There were some 1,500 roasters in 1923 (Ukers, W. H., *Coffee Merchandising,* 1924, p. 139). Obviously, a large part of the business is conducted on a small scale.

of the total movement of coffee to the establishments of the large roasters who do direct importing. The figure is sufficiently liberal to include any Canadian receipts.

Obviously, no use could be made of the St. Lawrence for shipments of roasted coffee. Nor would re-shipments of green coffee permit of such use.

III. Cocoa

Our imports of cocoa beans averaged about 203,000 tons in 1923-1927, a figure considerably in excess of the prewar average. Prepared cocoa and chocolate come in in very small amounts and need not concern us further.

Cocoa beans come principally from the West Indies, South America, and British West Africa. In 1927 nearly 90 per cent moved in through New York, the cocoa market of the United States.[9] Massachusetts, Philadelphia, and the Pacific Coast ports showed relatively small receipts, despite the fact that Pennsylvania, Massachusetts, and California, together with New York and New Jersey, account for over 95 per cent of the production of chocolate and cocoa products. Clearly the location of the industry and the marketing process are such that this product could not move in appreciable quantities over the St. Lawrence route.

Our exports of cocoa, or chocolate, small in amount, would permit of no use of the St. Lawrence.

Canada's imports of cocoa beans, paste, and butter have averaged a little over 10,000 tons in recent years, of which about one-seventh came from the United Kingdom and the remainder in equal amounts from the United States and all other countries. Montreal is the most important marketing center and doubtless would continue to be. However, a part of the movements, particularly from England, might be made directly into interior cities, such as Toronto. Possibly 1,000 tons could be put down under this head.

[9] The New York Cocoa Exchange, with dealings in futures, was established in the fall of 1925.

IV. Tea and Spices

1. *Tea.* Our imports of tea in 1925-1927 averaged less than 50,000 tons. Of this the greatest part is brought directly from the Far East, with a little over a fifth coming from England. New York is the port of entry for over half of our imports, Massachusetts and the Pacific ports accounting for nearly all of the rest. It does not appear probable that opening the St. Lawrence would work any change in the present situation. With a direct and short ocean haul to the Pacific ports and low, widely blanketed import rates for the rail haul to the interior of the country, it seems evident that a competitive rate could not be worked out via the St. Lawrence. Bearing in mind this situation as to rates and service, and also considering the various marketing practices which so largely govern the routing of commodities, we conclude that no traffic in tea, other than possibly a little moving irregularly, would use the St. Lawrence route.

Canada's imports of tea in 1925-1927 were at a rate of about 18,500 tons, of which perhaps two fifths came from the United Kingdom and the remainder direct from producing regions. A very large part comes in, of course, at Pacific Coast points. Of that coming in from the United Kingdom, perhaps a third could find its way directly over the St. Lawrence route, or, allowing for some growth of total imports from this region, 3,000 tons per annum.

2. *Spices.* We imported in 1925-1927 an average of 50,000 tons of spices, but these came from all over the world and in relatively small individual shipments. New York is preëminently the spice market of the country. In view of all that this fact implies and of the small volume of the business and the high specific value of spices, we can foresee no use being made of the St. Lawrence for the movement of such traffic.

Our exports of spices, small in extent and going mainly to Latin America, obviously would permit of no use of the St. Lawrence route.

Canada's imports of spices have been, we estimate, at about the rate of 3,100 tons per annum in recent years. Of these about two-fifths came from the United Kingdom and a third from the United States. The latter would, of course, move all-rail, and shipments from producing countries would go mostly to Montreal. Bearing in mind the small size of shipments and the importance of marketing factors, we yet may set down 500 tons of such traffic for movement directly into the Great Lakes via the St. Lawrence.

V. Fruits

1. *Bananas*. In discussing the possible movement of bananas over the St. Lawrence waterway route it is necessary to consider, first, the sources of banana production and the present import channels, and, second, the character of the commercial organization that has been developed for the handling of this perishable commodity.

A. The Import Trade in Bananas

The United States has in recent years imported annually around 1,500,000 tons of bananas. Over 90 per cent of the total comes from the tropical area bordering on the Gulf of Mexico.[10] Sources of imports are shown in the table on page 615.

Over 95 per cent of our banana imports enter through North Atlantic and Gulf Coast cities. New York and New Orleans are the great banana markets. Imports of bananas at other ports are for local consumption. Distribution of imports through North Atlantic and Gulf ports for the year ending June 30, 1927, are shown in the table on page 615.

The importation of bananas is continuous throughout the year. The conditions of growth and climate in the tropical areas enable the banana producer to have a high degree of control

[10] Pacific Coast ports import about 225,000 bunches annually from Hawaii.

Average Imports of Bananas [a]

Region	In Thousands of Bunches
Central American States	34,115
Caribbean Islands [b]	16,831
Mexico	4,518
Colombia	2,063
All others [c]	54
Total	57,581

[a] Compiled from *Foreign Commerce and Navigation of the United States.*

[b] Includes a small quantity of fruit from the Bermudas.

[c] Includes small shipments from various South American countries and some transshipped fruit.

United States Imports of Bananas Through Specified Ports [a]

(Cargo tons of 2,240 pounds)

North Atlantic			Gulf		
Port	Tons	Percentage of Total	Port	Tons	Percentage of Total
New York	543,970	72.6	New Orleans	524,021	80.7
Philadelphia	75,963	10.1	Mobile	94,577	14.6
Boston	92,313	12.3	Galveston	20,839	3.2
Baltimore	37,438	5.0	Tampa	10,039	1.5
Total	749,684	100.0		649,476	100.0

[a] Compiled from *Report* on Volume of Water-Borne Foreign Commerce of the United States by Ports of Origin and Destination, Bureau of Research, U. S. Shipping Board, 1927.

over his output. From the planting of the rhizome until the cutting of the mature bunch of bananas requires a period of 13 months. The individual plant is cut down upon the production of a single bunch of fruit, but a new plant springs up immediately from its roots, requiring in turn 13 to 16 months to develop a new stem. Barring the risk of loss from drouths and insects, the planter may therefore arrange for production in such consecutive cycles and in such quantities as he estimates he needs to meet the market demand.

The quantities of bananas received at the various North Atlantic ports are considerably heavier in summer than in winter as is shown in the table which follows.

MONTHLY IMPORTS OF BANANAS [a] BY COAST DISTRICTS
(In cargo tons of 2,240 pounds)

Month	North Atlantic	Gulf	Pacific	South Atlantic
January	29,069	32,001	498	....
February	32,799	35,534	621	....
March	54,040	45,793	413	....
April	60,122	49,828	1,315	....
May	54,340	56,473	625	30
June	75,051	68,065	815	63
July	93,305	62,778	133	172
August	80,387	57,572	865	96
September	66,286	48,806	1,346	295
October	53,900	50,444	815	298
November	41,723	39,573	1,194	195
December	41,188	43,425	978	314
Total	682,210	590,292	9,618	1,463

[a] For year 1925.

At New York and New Orleans bananas arrive almost daily, on a regularity of schedules approaching that of milk trains. For example, vessels with consignments of bananas arrived in New York for the week ending January 8, 1926, as follows:

January 4	3	vessels
" 5	1	"
" 6	1	"
" 7	1	"
" 8	2	"

In the summer of the same year three vessels brought in bananas on August 2, one on August 3, two on August 4, two on August 5, and two on August 6. At New Orleans the United Fruit Company's vessels arrive with bananas regularly on Wednesdays and Fridays; vessels of the Cuyamel line arrive two or three times per week; those of the Standard Fruit and Steamship Company every Monday; and those of the New Orleans Bluefields Fruit and Transportation Company every fourth day.

B. The Commercial Organization Required

The first essential for the successful marketing of bananas is the perfect control of temperature from plantation to consumers' table.[11] At the time of harvesting, bananas though green and unedible, are " ripe " in the sense that they no longer require food from the parent plant. Further changes in the green fruit after severing from the tree are entirely chemical, and are controlled by regulating the temperature and humidity. In fact, the banana is one of the few fruits which reach the higest perfection in food value and flavor when harvested green and is always cut green even when consumed locally in the tropics.

From plantation to retailers' store windows, therefore, heat or icing, depending upon the season, must be available to hold the fruit within a narrow range of temperature. In transit on the ocean vessels, the temperature is maintained at 53° F.[12] From the time of loading on the railroad refrigerator car at the port until sold to the consumer, the temperature is maintained at different levels, since the farther the distance to the consumer, the slower must be the ripening process. The following schedule shows the temperature which must be maintained: for

[11] The following discussion of marketing factors is based on information obtained from the United Fruit Company.
[12] *Fruit Dispatch,* Nov.–Dec., 1925, p. 295.

fast or forced ripening, 68°; for normal ripening, 62° to 66°; for slow ripening, 60°; for holding bananas green, 58°; for holding bananas ripe, 56°.

Control of the temperature obviously requires special care and equipment at every stage in the marketing process. On the short run from Central American ports to New Orleans, vessels equipped with special ventilation are frequently employed. For the longer run to New York, refrigeration must be used. The refrigerator vessels are pre-cooled for 24 hours before receiving the fruit, and they are also equipped for heating in winter, when necessary.

Wharves and passage ways at Northern ports are protected by canvas against cold winds and winter weather. Refrigerator cars are equipped with heavy insulation, false flooring, and ventilators. In the summer they must be iced frequently; in the winter they are heated after receiving fruit. During the winter months cars of fruit, in transit, are brought to proper temperature at specially equipped warming houses. For example, the Fruit Dispatch Company[13] operates three large fruit houses at Mounds, Illinois; Dubuque, Iowa; and Springfield, Missouri. These buildings are enclosed sheds, supplied with steam-fed overheated radiators, with fans and fan engines for supplying hot air to all cars of fruit simultaneously. The Mounds plant accommodates 72 cars at one time, the others each 40 cars at a time. For shipment in the northern part of the United States and Canada, protection is frequently provided by means of car heater stoves.

The icing of cars is supervised by trained men. To insure perfect control of temperature for each car of fruit and simultaneously reduce the time required for icing to a minimum requires a special knowledge of the banana industry. The United Fruit Company has, therefore, built up an organization of trained men known as " banana messengers " who accompany

[13] The Fruit Dispatch Company is a subsidiary of the United Fruit Company.

fruit shipments or meet the cars at icing stations. Arrangements have been perfected to such a point that " a string of 16 cars could be brought to an icing dock and in 14 to 15 minutes, each car will have been given its proper amount of ice and the cover of the vents will be in position as ordered." [14]

Jobbers maintain special ripening rooms. From the time the car of bananas is unloaded until it has been distributed in small lots to retailers the same control over heat, ventilation, and humidity must be maintained in the ripening rooms that is required in transit. Moreover, the jobber must be equipped to ripen the precise quantities which his trade desires and to hold his surplus in a wholesome green condition.

The second great essential in the marketing of bananas is speed. The following factors, based largely on the system used by the United Fruit Company, show how highly organized the tropical fruit industry has become.

The United Fruit Company maintains radio telegraph stations in Colombia, Costa Rica, Honduras, Nicaragua, Panama, Swan Island, and a terminal station in New Orleans. Smaller stations are maintained at Boston, and at Burrwood, Louisiana. The company owns 1,300 miles of railways and 500 miles of tramways in the tropics which it employs in transporting its fruit to the points of export.

Every effort is made to reduce the time required to market the fruit. The harvesting is done only on order from the selling organization. Special machinery has been developed to reduce the time required for loading and discharging banana cargoes. At the points of export, special conveyors lift the fruit into the holds of the steamships where it is stored in classified lots according to the number of " hands " of fruit to the stem. This separation of grades at the time of loading facilitates distribution at the point of destination. North Atlantic Coast ports use car-floats and stevedores for the handling of bananas. In the Southern ports, special unloaders and conveyors are

[14] *Fruit Dispatch,* July, 1926.

used. Six hours is the average time required to clear the ship after the process of unloading begins.

In order to distribute bananas from the points of import to the consuming centers in minimum time, the United Fruit Company has built up a system of branch houses throughout the United States and has established definite routes for distributing fruit. The efficiency of the marketing organization that has been developed is perhaps best tested by the fact that the time required to harvest the fruit, transport it by vessel and rail, and place it in the jobbers' ripening rooms ranges from seven to twelve days.

In the light of this analysis, it is clear that this traffic could not possibly utilize the St. Lawrence waterway. The primary requirement is not low freight rates but complete control of temperature from the producer to consumer and speed throughout the entire marketing process.

2. *Pineapples.* Fresh pineapples could not possibly make use of the St. Lawrence waterway because of the requirements of speed in delivery. The case is similar to that of bananas and does not need to be discussed further.

Canned pineapples come chiefly from Hawaii, by way of San Francisco and rail to Middle Western points of distribution. The total quantity of this product consumed in Ohio, Indiana, Illinois, Wisconsin, and Michigan amounts to about 50,000 tons annually.[15] In view of the great distance involved by boat and the lack of back-haul traffic that would justify the establishment of regular services between the Great Lakes cities and either Hawaii or the Orient, and in view of the fact that the commercial organization of the industry has been built up through San Francisco, we do not believe this traffic would utilize the St. Lawrence route.

3. *Other fruits.* The other important fruit imports are lemons, currants, figs, dates, and raisins. These fruits come chiefly

[15] Computed on the basis of the estimated population of these states and the average per capita imports of canned pineapple for the United States as a whole.

from south European countries and the Near East. They have to be considered in connection with Mediterranean traffic in general, in relation to the St. Lawrence. In addition to fruits we import from the Mediterranean area olives, olive oil, onions, canned tomatoes, cheese, nuts, oriental rugs, silks, embroideries and laces, pottery, and miscellaneous high grade products such as sheep and goat skins, vegetable tannins, cork, tobacco, and millinery goods. Varied traffic of this kind would not make use of a seasonal water route.

APPENDIX K

THE DEVELOPMENT AND THE UTILIZATION OF THE POWER OF THE ST. LAWRENCE RIVER IN THE INTERNATIONAL SECTION

SAN FRANCISCO CHICAGO

SANDERSON & PORTER

ENGINEERS

52 WILLIAM STREET NEW YORK

January 15, 1929.

Dr. Harold G. Moulton, President,
The Brookings Institution,
26 Jackson Place,
Washington, D. C.

Dear Sir:

In compliance with your request, we submit herewith our report entitled—

The Development and the Utilization
of the
Power of the St. Lawrence River
in the
International Section

Yours very truly,
Sanderson & Porter.

CONTENTS

INDEX OF TABLES

THE DEVELOPMENT AND THE UTILIZATION OF THE POWER OF THE ST. LAWRENCE RIVER IN THE INTERNATIONAL SECTION

The Power Aspects of the St. Lawrence River Project

In this study of the power aspects of the project to improve the navigation and develop the power of the St. Lawrence River, free use has been made of available data on the subject, particularly that contained in the recent "Report of Joint Board of Engineers on the St. Lawrence Waterway."

This study is concerned mainly with the bulk transmission of the St. Lawrence energy available to the United States to either of two load centres,—the Metropolitan District around New York and the New England District around Boston.

It also considers other means of disposal of the energy.

The conclusions reached in this study are that:—

(a) The development of the International section of the St. Lawrence River would make available a large block of power which can be used in only a limited number of markets.

(b) In these markets, St. Lawrence power can be sold only if it is cheaper, including the cost of reserves, than reliable power produced locally.

(c) The Metropolitan market in and around New York City can absorb the U. S. part of the St. Lawrence power, but the costs of generation and transmission of the energy are greater than the cost of equivalent steam energy generated locally.

(d) This is true also of the market comprising Boston and the eastern part of New England; moreover, cheaper hydro-power from Maine may be made available there.

(e) The market in central and eastern New York State surrounding Utica and Schenectady is now too small to absorb the whole of the St. Lawrence power.

(f) The most promising eventual outlet for St. Lawrence power is the development of a high load-factor market near the River, using all of the power at this market, or using a portion of it there and sending a part to New England and to Utica.

(g) Power from the St. Lawrence is intrinsically inferior in reliability to locally generated steam power,—and hence must be marketed at a lower rate to provide for the cost of reserve capacity.

(h) Wherever this power may be sold, there will of necessity be heavy carrying costs in excess of earnings during the development period; these are essentially a capital cost and increase the price of energy to the user; but they have not been included in these estimates.

General Considerations

The power development of the St. Lawrence River from Lake Ontario to Montreal should be considered in two sections—first, the International section from Lake Ontario to Cornwall; and second, the Canadian section from Cornwall to Montreal.

The Canadian section is entirely within the Province of Quebec, and questions of power thereon concern Canada alone; the United States is interested only in a navigable waterway to the ocean through this section.

The total potential power in the River between Lake Ontario and Montreal is approximately 4,080,000 electric horse-power (3,040,000 kw.), based on an average water supply of 187,000 second-feet with an average fall of 226 feet from Lake Ontario to Montreal, and an efficiency of 85% to the high pressure terminals of the step-up transformers.

Power developed on the International section would belong to the two nations and the development must be a joint undertaking. The loss due to independent developments would be great and would lessen the utility of the River both from the point of view of navigation and of power.

At present the Dominion government and the Provincial governments are opposed to the exportation of additional power

from Canada to the United States. Their position is that the national policy should be to develop Canada's hydroelectric power resources for home use, and as an inducement to foreign capital to build manufacturing plants and develop industries in Canada. It is stated by the Ontario Hydro-Electric Commission that there is an abundant market in Canada to absorb all the power that Canada can develop as it is made available.

The Report of Joint Board of Engineers, composed of United States and Canadian engineers, on the St. Lawrence Waterway Project has recently been made public. It includes a full discussion of the plans for the development of the International Section, for power and navigation jointly, for power separately, and for navigation separately.

Two plans for the joint development of the power in this Section are presented.

1. A two-stage development, favored by the Canadian section of the Engineering Board, with the upper dam at Ogden Island and the lower dam at Long Sault Island, the lower level to be at elevation 224 feet and the upper that of Lake Ontario, approximately elevation 242.5 feet. The estimated cost of this two-stage development for power alone, excluding that part of the cost which is chargeable solely to navigation in the section, is $231,065,000, including an installed capacity of 2,215,000 horse-power. The cost chargeable exclusively to navigation is estimated at $33,481,000, making a total of $264,546,000 for the complete development. An alternative to the second stage of this plan is to put the lower dam at the foot of Barnhart Island, on the same alignment as that of the single-stage development.
2. A single-stage development, favored by the United States section of the Engineering Board, with a dam at the foot of Barnhart Island and a control dam at the head of the Galop Rapids, extending across the entire river with the exception of the navigation channel. This control dam is for the purpose of regulating the level of Lake Ontario; the pool elevation is to be held between 240 and 244 feet. The estimated cost on this plan, excluding that part chargeable solely to

> navigation in the section is $213,000,000; the cost chargeable exclusively to navigation is estimated at $22,000,000, making a total of $235,000,000 for the complete development. The total installed capacity is 2,326,000 horse-power.

The Joint Board of Engineers estimates the cost of the single-stage power development of the International Section, eliminating works solely for navigation, as follows:

TABLE 1

JOINT BOARD ESTIMATE OF COST TO BUILD THE SINGLE-STAGE POWER DEVELOPMENT

Works common to navigation and power	$ 106,500,000
Works primarily for power—	
Substructures and head and tail race excavation	42,000,000
Superstructures and machinery	64,500,000
Total cost (2,326,000 horse-power)	$ 213,000,000
Initial cost with installation of one-half of the power	$ 181,000,000

This total of $213,000,000 for the development of power alone does not include several elements of cost that must be incurred whether private or public interests do the work. First, there would necessarily be a large sum spent in preliminary expenses. It is stated that one corporation which has applied to New York State for a license to develop this power has already spent more than $7,000,000 on the project. If the permanent works are done by public authority and the equipment is put in under private ownership, there will still be a substantial amount to be expended for preliminary expenses. Nevertheless, it is not included in the estimates herein as the amount is indeterminate; the estimates are therefore low by whatever amount is thus expended.

There is also the important item of interest during construction, which the Joint Board Report estimate omits. It is stated that the preliminary and construction periods will cover about eight years. A very considerable amount of the money will be expended during the first year and a large amount during each

subsequent year, including the major portion of the cost of the equipment in the final year. Assuming, however, that funds are expended at a uniform rate, the average period for the computation of interest on the total amount will not differ appreciably from four years.

Capacity of the U. S. Section of the Generating Plant

The principal factor determining the estimated output of this station is the average stream flow assumed as the basis for the development.

The idea is prevalent that the hydraulic régime of the Great Lakes is very regular, whereas in fact the water supply varies over a wide range, the range being from a monthly net supply exceeding 800,000 second-feet to a negative net supply, that is, a month in which the evaporation is greater than the inflow. The average monthly net supply for April and May exceeds 500,000 second-feet, while the average for November is less than 20,000 second-feet. Despite this and due to the great reservoir capacity of the Lakes, the discharge from Lake Ontario, according to the Joint Board Report, has ranged between the limits of 318,000 second-feet and 174,000 second-feet for the past 65 years.

Assumptions made for the average flow at Barnhart Island, vary from 200,000 to 230,000 second-feet. These assumptions are based on discharge measurements of the St. Lawrence River and do not take into consideration the fact that during recent years the average discharge of the River has been greater than the average net water supply, with consequently a progressive lowering of the Lake levels.

The average net supply to the Great Lakes system was less for the years 1921-1925 than for any prior period. The United States Lake Survey Office has supplied the figures given in Table 2, showing the net supply to the Lakes and the discharge from Lake Ontario for these five years.

The term "net supply" means the total quantity of water flowing into the Lakes, plus the rainfall on the Lakes minus evaporation from their surface. This net supply has varied during these five years from 160,000 second-feet to 223,000 second-feet, the average for the period being 195,800 second-feet. For the same period the average discharge from Lake Ontario has been 219,860 second-feet, 12% greater than the average supply.

The maximum flow that can properly be assumed as the basis for the permanent power of this development is 195,800 second-feet, the average net supply for this five-year period. It would be more conservative to use 160,000 second-feet, the net supply for 1925, on the assumption that it might not prove to be practicable to provide for the regulation of the discharge of the Lakes over a period of five years; however, to make a better showing for the project, the mean or average five-year net supply of 195,800 second-feet is used herein as the datum for the estimation of the permanent power output of the generating station.

Table 2

NET SUPPLY TO THE LAKES AND DISCHARGE FROM LAKE ONTARIO FOR 1921–1925

Year	Mean Net Supply in Cubic Feet per Second	Mean Annual Discharge in Cubic Feet per Second
1921	198,000	229,600
1922	223,000	228,600
1923	199,000	213,400
1924	199,000	221,100
1925	160,000	206,600
Five-year mean	195,800	219,860
Ratio	100	112

All diversions of water must be deducted from the average net supply in order to arrive at the average regulated discharge of the St. Lawrence. The principal diversion is at Chicago.

Under a temporary permit from the United States War Department, the Sanitary District of Chicago diverts an average yearly flow of 8500 cubic feet per second from Lake Michigan through the Chicago drainage canal into the basin of the Mississippi River. In addition, the City pumps water from the lake for its domestic water supply. During the last five years the average diversion for both purposes has amounted to 8660 second-feet. The matter of diversion is now the subject of a judicial proceeding between Illinois and the several states interested. While the findings of the Court cannot be foretold, it is conservative to assume as a minimum that the authorized diversion of 8500 second-feet, plus 300 second-feet for minor diversion, making a total of 8800 second-feet, will continue.

With a diversion of 8800 second-feet the five-year average regulated outflow of the St. Lawrence becomes 187,000 second-feet. The question then arises whether the United States is entitled to one-half of the average net supply to the Lakes or to one-half of the estimated average regulated outflow of the St. Lawrence. In the first case the United States would be entitled to the use of half of 195,800 second-feet, 97,900 second-feet, from which 8800 second-feet is to be deducted for the Chicago diversion, leaving 89,100 second-feet as the flow at Barnhart Island to which the United States would be entitled; Canada would then have the use of 97,900 second-feet flow at Barnhart Island. In the second case the United States would be entitled to half of 187,000 second-feet at Barnhart Island, 93,500 second-feet, which is 4400 second-feet more than in the first case.

The second assumption is herein adopted, that is, that the United States will have the right to 93,500 second-feet at Barnhart Island. This is based in part on the claim that considerably more than half of the inflow to the Great Lakes comes from the United States, and again it gives a lower cost per unit of output.

The Joint Board Report states that the summer head at Barnhart Island will be approximately 85 feet, and that this will diminish under winter conditions to 75 feet.

With an average summer head in the International section of 85 feet, a flow of 187,000 second-feet and an efficiency of 85% to the high pressure terminals of the transformers, the average summer power is 1,540,000 electric horse-power (1,150,000 kw.) With the head in winter at about 75 feet, the corresponding power is 1,350,000 electric horse-power (1,010,-000 kw.), for the same flow. When the winter flow falls to 160,000 second-feet the corresponding power will be 1,160,000 electric horse-power (865,000 kw.). The weighted average of the summer and winter heads may be taken at 83 ft., which, with the regulated flow of 187,000 second-feet, is 1,500,000 horse-power (1,120,000 kw.)

On the assumptions made herein, one-half or 750,000 horse-power (560,000 kw.) of the average that can be developed in the International section belongs to the United States, the other half to Canada. Of the total potential power in the River between Lake Ontario and Montreal, Canada therefore owns 82% and the United States 18%. These are round figures applying to the average power.

The 560,000 kilowatts belonging to the United States will yield approximately 4900 million kilowatt-hours per year, and this amount of energy is taken as the average net total output of the United States part of the generating station.

However, this entire amount of energy is not available to the United States for transmission or sale. The Aluminum Company of America has the right to divert 25,000 second-feet of water at the Long Sault Rapids, through the Massena Canal to its power house on the Grasse River. Under the present average head of about 40 feet, approximately 60,000 kilowatts and 500 million kilowatt-hours are developed and used in its Massena plant. If the Aluminum Company should not yield its right to this amount of water, the flow tributary to the United States section of the plant would be 68,500 second-feet

and the power would be reduced to 410,000 kilowatts, with an average energy of 3600 million kilowatt-hours.

If, however, as herein assumed, the Aluminum Company should be willing to yield its right to this flow in return for an equivalent amount of power and energy, there will be a deduction of 60,000 kilowatts from the output of the United States section of the plant, leaving 500,000 kilowatts, and of 500 million kilowatt-hours, leaving about 4400 million kilowatt-hours as the energy deliverable at the River to the United States transmission lines.

From this amount there should also be deducted the equivalent of the water necessarily used in passing floating ice over the dam. During the late winter and spring months this may represent a considerable quantity of energy for which no allowance has been made in this discussion. Nor do these considerations take into account the possibility of even lower flow at times than the regulated 187,000 second-feet, due to ice obstruction of the channel. The Joint Board Report states that the winter head may be about 75 feet; if the winter flow falls to about 160,000 second-feet, the salable portion of the United States share of the power will be reduced to about 390,000 kilowatts, assuming a proportionate reduction in the Aluminum Company's allowance. Although ice obstructions may not affect the average energy output assumed, the permanent power is affected, even though the obstructions continue for a few days or weeks only.

Generating Station

As previously stated, the average output of the United States generating station is 560,000 kilowatts and 4900 million kilowatt-hours, based on a flow of 93,500 second-feet, a head of 83 feet, and an efficiency of 85% from the water to the 220-kv. side of the transformers. The Joint Board Report recommends that the variation of the pool level above the dam be held within close limits and that the operation of the plants must be as nearly as possible at 100% daily load-factor due to the necessity

for maintaining constant water level at Montreal. It is therefore assumed herein, that the installed capacity of the generating stations, Canadian and United States, is to be adequate only to use a flow one-third greater than the average of 187,000 second-feet, equal to 250,000 second-feet, under 83-foot head, of which half is in the United States section. The installed capacity of the United States generating station will then be 750,000 kilowatts.

To compensate the Aluminum Company for its water rights, it is assumed that a separate section of the main power house, having a maximum installed capacity of 12,500 second-feet (75,000 kw.) is segregated for the supply of this load. The remainder of the installed capacity of the United States generating station (675,000 kw.) is assumed to be divided into six sections, each having a capacity of 112,500 kilowatts and 125,000 kv-a., probably in three units of 37,500 kilowatts each with each section connected only to one of the total of six transmission lines extending to the substations of the ultimate market, without interconnections at the generating station to any of the other lines

The United States generating and transmission system is then made up of six independent units, of which five can supply the peak load in an emergency; in case of failure of a line, the connected section of the generating station will be out of service. The Aluminum Company's generators are not to be connected to the main transmission lines; this arrangement is assumed in order to ensure the identity of the sections of the generating plant and of the transmission lines. If the power for the Aluminum Company were to be taken from any one of the main power house sections, the amount of power remaining for that particular transmission line would be less than that of the others and the relay capacity of the plan would be lessened.

The principal data for the United States section of the generating station are summarized in Table 3.

TABLE 3

PRINCIPAL DATA OF U. S. SECTION OF GENERATING PLANT

Maximum flow to U. S. section..........	125,000	second-feet
" " " Aluminum Co. of America	12,500	" "
Balance available for other use.........	112,500	" "
Capacity installed	750,000	kilowatts
Allocated to Aluminum Co. of America...	75,000	"
Balance available for other use........	675,000	"
Average flow to U. S. section.............	93,500	second-feet
" to Aluminum Co. of America....	10,000	" "
Balance available for other use..........	83,500	" "
Average head	83	feet
" efficiency, forebay to 220 kv. lines	85%	
" power, exclusive of Aluminum Co.	500,000	kilowatts
" energy to transmission lines, per year	4,380	million kw-hr.
Total capacity of transmission lines.......	750,000	kv-a.
Number of lines	6	
Capacity per line	125,000	kv-a.

Capital Cost of the U. S. Section of the Generating Plant

The Joint Board estimates on an installed capacity of 2,326,000 horse-power—of which half, 1,163,000 horse-power (868,000 kw.), is allotted to the United States. We assume a smaller installation, 1,000,000 horse-power (750,000 kw.); the reasons for this difference in capacity are given elsewhere. The estimated cost of the United States half of the development based on the Joint Board figures is given in Table 4; the figures of the Joint Board in this table include 12.5% for engineering, administration and contingencies, but exclude interest during construction. We assume this allowance of 12.5% for engineering, administration and legal expense, and add interest and contingencies.

The entire work including the equipment of the generating station is herein assumed to be done by public authority, either the United States or the State of New York—in order to secure low rates for money and hence low cost of energy. Under public authority, 4% is taken as the interest rate applying during construction and subsequent operation. For the assumed construction period of eight years and an average interest period of four years, the total charge for interest during construction will then be 16%. The allowance for engineering and superintendence, legal expense and administration during construction is taken at 12.5% on the items added to the Joint Board's costs; and added to all these, long experience has proved the necessity of an item for omissions and contingencies, for which 20% is the minimum that can safely be assumed for works of this kind. Contingencies are supposed to be included in the overall 12.5% added by the Joint Board,—but this amount is not adequate to cover contingencies.

TABLE 4

ESTIMATED COST TO BUILD AND EQUIP THE U. S. SECTION OF THE SINGLE-STAGE POWER PLANT

1. Works common to navigation and power (Joint Board)	$106,500,000
2. Substructures and tail race excavation (Joint Board)	42,000,000
3. Sum	$148,500,000
4. U. S. Part, 50% of item 3	$ 74,250,000
5. Superstructure, cranes, etc.	7,500,000
6. Equipment at $30	22,500,000
7. Engineering and administration, 12.5% items 5 and 6	3,750,000
8. Sum 4, 5, 6 and 7	$108,000,000
9. Omissions and contingencies, 20%	21,600,000
10. Interest during construction, 16%	20,700,000
11. Total cost	$150,300,000
or, in round figures	$150,000,000
Cost per kilowatt of capacity	$ 200

The construction cost of the two-stage development as estimated by the Joint Board is approximately $18,000,000 greater than for the single-stage plan. In the estimates herein, the single stage development is used as the basis, as its cost is less and therefore makes a more favorable showing for the project.

This estimate charges to power development the total cost of the works common to navigation and power. There would be no appreciable change in the cost of these works if provision for navigation were not a part of the project.

Annual Cost of Generating Plant

The total annual cost of the generating plant should include charges for management, operation and maintenance, insurance, taxes (local, state and federal), license fees to be paid to New York and to the United States, interest and amortization on the investment, and profit. These charges are practically independent of the output of the plant. The production costs of the Aluminum Company's section are taken as a charge against the remaining U. S. energy.

Table 5 shows the estimated annual costs of the generating plant when in full operation, with 4% for interest and 1% for sinking fund to retire the total cost in about 50 years. No federal income tax is charged here as the sale of energy is assumed to be at cost.

The estimated annual cost given in Table 5 is based on the assumption that the generating works are built by the State and upon completion are leased to a private company for operation.

The State should then receive, in addition to interest on the total investment and amortization of this investment, an amount at least equal to the taxes that would be paid to the State if the property were privately owned.

The license fee that was proposed under recent acts of the New York Legislature to be levied upon the private operator of these properties, which would have been in addition to taxes, was $2.25 per average horse-power. This was a payment for

the use of such rights as the State holds in this property; the private owner would have been under the necessity of purchasing all the real estate required, and paying all damages, in addition to supplying the entire capital needed for the construction of the works.

TABLE 5

ESTIMATED ANNUAL COST OF GENERATION FOR THE U. S. HALF OF THE GENERATING PLANT AT BARNHART ISLAND, UNDER A PRIVATE OPERATING COMPANY BASED ON CAPITAL EXPENDITURES OF $150,000,000 FOR THE U. S. SECTION FOR AN INSTALLED CAPACITY OF 750,000 KW.

1. General expense, management, legal and insurance		$ 500,000
2. Operation, labor and materials at $1.00 per kw....		750,000
3. Maintenance and renewals of structures and equipment		1,000,000
4. Rental payable to the state:		10,688,000
a. Interest on capital, 4%............	$6,000,000	
b. Amorization of capital, 1%........	1,500,000	
c. In lieu of taxes, 1%................	1,500,000	
d. License fee, $2.25 on 750,000 average horse-power	1,688,000	
5. Federal License Fee, at $0.25 per h. p. of "power capacity"		160,000
6. Total Annual Cost		$13,098,000
or, in round figures		$13,000,000

If it were fair to require a private operator to pay this license fee of $2.25 when the property is entirely owned by him, it certainly is reasonable to ask the same amount as the license fee when the private operator is relieved of the necessity of finding the capital required to build the works.

If the rental charge does not include an item equal to the taxes that would be paid by a private operator, then one class

of the community is subsidized at the expense of the general public. Taxes are taken at 1% on the capital cost, probably an underestimate. The Niagara Falls Power Company pays about 2%. The only item in the total rental charge that is in payment for the right to use this public resource is the license charge of $2.25 on the installed capacity. The other items are in the nature of repayment to the State for expenses incurred by it. Item 5 is the amount of the Federal license fee that is required of all hydroelectric projects on navigable streams; it is based on a charge of $0.25 per horse-power of "power capacity." In this case the estimated power capacity is 640,000 horse-power.

The sum of these amounts, $13,000,000, is the total annual cost chargeable to the generating plant; it is equal to 2.66 mills per kilowatt-hour of the average output of the generating plant, 4900 million kilowatt-hours; deducting the 500 million kilowatt-hours allocated to the Aluminum Company, the total cost is equal to 2.95 mills per kilowatt-hour of energy available for transmission; it is also equivalent to 3.42 mills per kilowatt-hour of delivered energy, 3800 million kilowatt-hours.

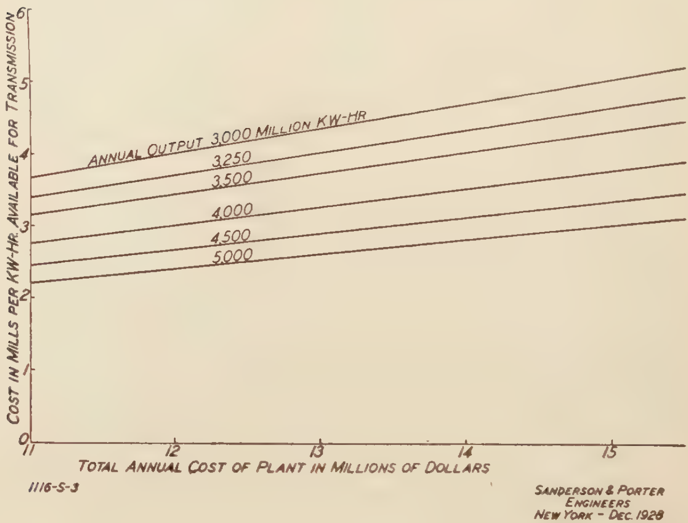
With a total annual cost of $13,000,000, a fixed amount practically independent of the output, the unit costs for several outputs are:

Output Million Kw-hr.	Cost per kw-hr. Mills
3500	3.72
3750	3.47
4000	3.25
4250	3.06
4380	2.97
4500	2.89
4750	2.74
5000	2.60

Figure I shows these data in graphical form; it may be used for intermediate values of output. For the estimated average output of 4380 million kilowatt-hours, the unit cost is practically 3.00 mills per kilowatt-hour.

FIGURE 1.—COST OF ENERGY AVAILABLE FOR TRANSMISSION PRODUCED BY U. S. SECTION OF POWER PLANT

St. Lawrence Power Project



Possible Markets

The possible markets for St. Lawrence River power are shown on Plate I as these districts have been blocked out for this study. The exact boundaries are not of importance. For discussion herein they are referred to as:—

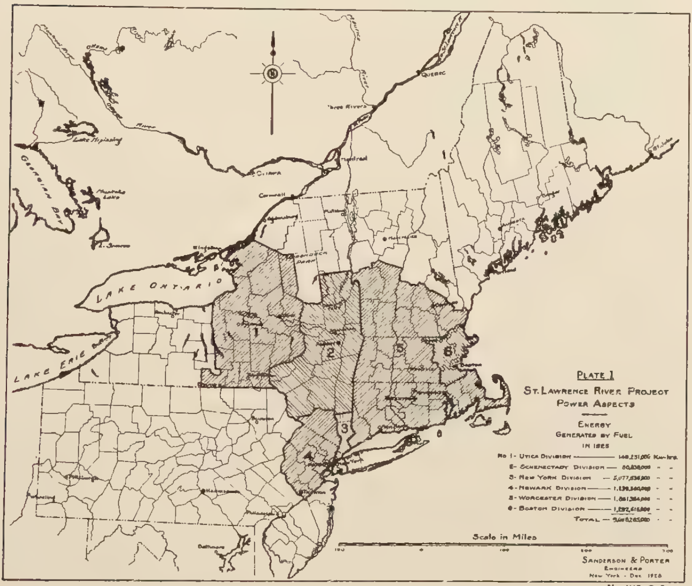
(a) The Metropolitan District around New York City (Divisions 3 and 4)
(b) The Boston District (Division 6)
(c) The Worcester District (Division 5)
(d) The Utica-Schenectady District (Divisions 1 and 2)

and in addition

(e) The Local District at the River, combined with delivery of some part of the energy to a Superpower System at Utica and Hoosic.

It is shown subsequently that the cost of St. Lawrence energy delivered at the Metropolitan District is in excess of the cost of energy generated locally by steam plants, and that, therefore,

PLATE 1.—ENERGY GENERATED BY FUEL IN 1925



such delivery of transmitted energy is not economical and in all probability will never be undertaken. In order, however, to show as favorable a case as possible for this transmission, it is assumed that the entire available U. S. share of the St. Lawrence energy is transmitted to the Metropolitan District and that the transmission system is designed to produce the minimum cost of delivered energy. This is the first case considered.

The second case to be considered is that the entire energy is delivered to the combined Boston and Worcester Districts. These markets will be sufficient in extent to absorb the entire energy as base load when the plant is in operation, and the costs of transmitting to these points will be less than to the Metropolitan District. As before, in order to make the costs of transmission as low as possible, the most favorable system of transmission lines for this particular delivery is set up. The result of this study, as shown hereafter, is that St. Lawrence energy cannot be delivered to the combined Boston and Worcester Districts at a marketable cost, and these districts must also be ruled out as a possible market.

The third possible market is in central New York State, extending east and west from Utica, along the line of the New York Central Railroad. The westerly end of this territory will meet competition from Niagara and on this account consideration is limited to the Utica-Schenectady District as shown in Plate I. The result of this study is that the load in the territory at the present time is too small for economical transmission from the St. Lawrence, and there are other cheaper sources of hydro-energy available for small increments of power. This district may ultimately take some small part of the St. Lawrence power, but it cannot be regarded as an adequate outlet and, therefore, cannot be held to justify the construction of the St. Lawrence plant.

The remaining and most promising market for St. Lawrence energy is local use, practically at the River. Utilization at high load-factor is necessary and therefore an electrochemical, electrometallurgical, or similar load is imperative. Unless such a load can be assured in advance, it seems to be impossible to develop any profitable outlet for St. Lawrence power.

Should there be a demand by the electrochemical and electrometallurgical industries or manufacturing establishments at the River, a portion of the St. Lawrence power could be sold to these industries, sufficient power to supply New England's requirements could be transmitted to Hoosic, and a third por-

tion could be transmitted to Utica to take care of any requirements of the proposed interconnection of the power companies extending from Niagara down the Atlantic seaboard to Washington, bearing in mind that the New York Central Railroad will undoubtedly electrify and will use a large block of power, to be purchased from the interconnected power companies and distributed over its own transmission lines.

The Probable Future Load in the Possible Markets

The total energy produced in the public utility plants in each state that may be considered tributary to the St. Lawrence

TABLE 6

ENERGY PRODUCED IN 1925 BY PUBLIC UTILITY POWER PLANTS IN THE STATES TRIBUTARY TO THE ST. LAWRENCE

(In thousand kilowatt-hours)

State	Fuel	Water	Total
Maine	22,651	486,491	509,142
New Hampshire	40,851	222,872	263,723
Vermont	6,406	251,568	257,974
Massachusetts	1,865,710	512,130	2,377,840
Rhode Island	403,174	5,034	408,208
Connecticut	847,172	159,740	1,006,912
New England	3,185,964	1,637,835	4,823,799
New York	5,781,294	4,484,970	10,266,264
New Jersey	1,503,979	2,154	1,506,133
Total	10,471,237	6,124,959	16,596,196

is reported by the U. S. Geological Survey, separating energy generated by fuel from energy generated by water. For 1925 these figures, given in Table 6, show that the total energy from fuel in these states was 10,471 million kilowatt-hours, more than twice that available from St. Lawrence power; and from water, 6125 million, making the total generated from fuel and water, 16,596 million kilowatt-hours.

As shown on Plate I, the entire territory included in Table 6 is not considered to be available as a possible market for St. Lawrence power. The data of electric energy generated in 1925 from fuel or from water in each of the public utility plants in these states considered have been supplied by the U. S. Geological Survey. From these data for the individual plants, the energy generated in the excluded territory has been estimated and has been deducted from the totals in Table 6. The remainder summarized to show the total energy generated from fuel in 1925 within the limited districts of Plate I, assumed herein to be available as a market for St. Lawrence power, is given in Table 7.

TABLE 7

ELECTRIC ENERGY GENERATED FROM FUEL IN 1925

(In million kilowatt-hours)

District	1. Utica	146
"	2. Schenectady	81
"	3. New York	5078
"	4. Newark	1240
"	5. Worcester	1862
"	6. Boston	1293
	Total	9700

The difference between the 9700 million above and 10,471 million kilowatt-hours of Table 6, represents the energy in the western and northern parts of New York State, in Maine, and in southern New Jersey, all of which are excluded. It is assumed that no power will be transmitted to Maine, which is adequately supplied with hydroelectric power, and that western and northern New York will be supplied by Niagara, by the Adirondack streams, or by steam, or by a combination of these sources.

The growth of the total central station load in this territory has been estimated in several recent engineering investigations, in particular, in the "Superpower Report for the Region between Boston and Washington" published by the U. S. Geo-

logical Survey in 1921, in "Super Power Studies, Northeast section of the United States" published by the Federal Power Commission in 1924, and in "Report to the Associated Industries of Massachusetts" published in April 1924. These three reports contain careful estimates of the growth of the load in their

TABLE 8

YEARLY OUTPUTS GENERATED IN THE METROPOLITAN DISTRICT—NEW YORK AND NEWARK

(In million kilowatt-hours)

	1918	1919	1920	1921	1922	1923	1924	1925
Light and Power..	1657	1863	2157	2267	2620	3026	3431	3822
Street Railways...	1494	1602	1631	1623	1760	1856	1897	1951
Railroads........	336	365	411	423	430	469	473	505
Total........	3487	3830	4199	4313	4810	5351	5801	6278

respective territories and are in fair agreement. The Associated Industries of Massachusetts Report, the most recent, gives the following estimate of the growth of load:

It is expected that on an average for the next ten years the load on the public utilities will increase each year by the following amounts, which may be regarded as a conservative estimate:

For the Massachusetts-New Hampshire-Rhode Island group centering around eastern Massachusetts 90,000 kw. net additional capacity will be required and 190,000,000 kw-hr. generated; for all New England 140,000 kw. and 300,000,000 kw-hr.

This would mean that during the next ten years approximately 1.400,000 kw. of central station capacity must be added to that already existing in New England, in addition to replacements.

This minimum growth of 300 million kilowatt-hours per year is assumed to be 200 million for the Boston District, and 100 million for the Worcester District, as defined in this study.

Table 8 from other authoritative private sources gives the loads in the Metropolitan District from 1918 to 1925 inclusive, divided into Light & Power, Street Railways, and Railroads.

The increase in the total for the 7 years is 2791 million, practically equal to 400 million kilowatt-hours per year.

The above estimate of the growth of load in the Metropolitan District is probably a minimum, as much greater growth has been predicted by good authorities. For instance, a pamphlet issued by the Empire State Gas & Electric Association in October, 1926, contains the following:

> In 1925 the people of New York State used in round numbers 10 billion kilowatt-hours of electricity, which was one-sixth the consumption of the entire country. At the present rate of increase, the use in 1930 may be estimated conservatively to be well over 16 billion kilowatt-hours, and in 1935 about 26 billion kilowatt-hours. In all probability it will reach 30 billion kilowatt-hours by that date.

That is to say, the growth estimated therein is 16 billion kilowatt-hours in ten years for New York State as a whole, 60% of this would be for the Metropolitan District, equal to about one billion kilowatt-hours per year, or 2.5 times as great as the growth shown in Table 8.

Weighing these estimates, an annual growth of 300 million for the New England District and 500 million for the Metropolitan District is assumed, totaling for these two districts an increase of 8000 million kilowatt-hours in ten years. At these rates of increase, the Metropolitan District will in 1935 generate about 11,500 million, and the New England District, about 6150 million kilowatt-hours. These estimates are probably low but, for the purpose of this report it is not necessary to assume a greater growth nor is great accuracy of the figures required. It is necessary only to show that there is an adequate market.

The data just discussed are based on the amounts of steam generated energy in the several districts in 1925, to which is added the total predicted increase in the loads in the several districts. It is therefore assumed that the energy from water does not increase substantially during this period,—that is,

the entire growth is taken to be part of the load that may be acquired by St. Lawrence power.

It is absolutely necessary that the St. Lawrence power be delivered at high load-factor in order that the unit costs may be low. It is therefore necessary to consider not only the size, but also the characteristics of the total load in the several markets in order to determine what part of this total available load has a sufficiently high load-factor to constitute an economical load for the St. Lawrence power. For this purpose it is necessary to make an analysis of the load curves of the markets.

Characteristics of the Prospective Loads

An analysis similar to that developed in the Superpower Report of the load conditions of the Metropolitan District and the New England District as they now are, shows conclusively that there will be no difficulty in allocating loads with load-factors of from 85 to 100% to the St. Lawrence power. It may not be feasible on account of difficulties incident to operation of this system to hold the load-factor as high as 90 to 95%. It is assumed, however, that a load factor at least equal to 80% can be reached and the equipment and costs are based on supplying such a load.

For instance, the total energy in the Metropolitan District in 1935 was approximately 11,500 million kilowatt-hours. The energy from the St. Lawrence, 3800 million kilowatt-hours, is therefore 33% of this total. Delivered as a base load 100% load-factor this would require about 15% of the total peak and therefore would call for a peak load for this district of about 2,900,000 kilowatts. The estimate of the load of the New York Edison Company alone for 1935 is a peak of approximately 2,200,000 kilowatts, and 1940, 3,300,000 kilowatts. Most favorable conditions as to load-factor for the delivery of St. Lawrence energy, therefore, exist in the Metropolitan District. The New England district, in which the conditions are not as favorable

as in the Metropolitan District, nevertheless, shows that the St. Lawrence energy can be delivered at a load-factor better than 80%.

The question then becomes not the size of the available market in these two districts, but solely the cost and reliability of delivered energy. As shown hereinafter, the cost to deliver to the Metropolitan District is materially greater than to New England, due largely to the cost of attaching the transmitted power to the distribution system; on the other hand, the cost for the New England district is increased by reason of the lower load-factor and by the delivery of the energy to several places. Of this latter item no specific account is taken in the estimates.

Transmission System

To deliver St. Lawrence River energy either to the Metropolitan or the New England District requires a system of transmission lines operated at the highest practicable pressure. Under present conditions it is not conservative to assume higher than 220,000 volts pressure.

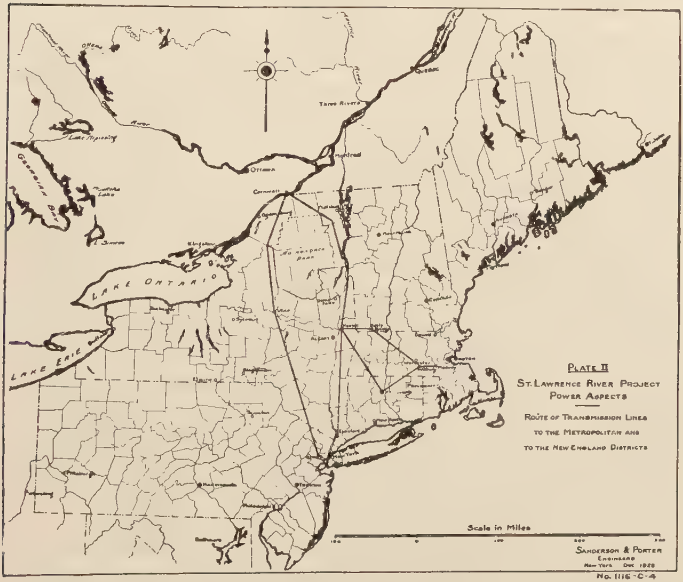
The transmission system has been laid out for good regulation and low losses. The capacity taken for a single circuit, 125,000 kv-a., at the River, is fixed without specific consideration of possible limitations imposed by the question of stability. This matter is of consequence and before construction is undertaken much study will have to be given to it. At the same time, it is felt that the importance of this aspect of a transmission system has been somewhat exaggerated in recent studies. The question of stability depends principally on the instantaneous and accurate control of the excitation of synchronous machines. It seems reasonable to expect that when the demand arises means will be found to secure adequate control of excitation, a beginning having already been made in the use of mercury arc rectifiers for auxiliary excitation. If other means fail the transmission can be made at a frequency of 25 cycles, instead of the standard 60 cycles herein assumed.

The only immediate concern here is the cost of such a system. The estimates herein given are considered adequate to meet any conditions that may prove to be necessary to insure the operating stability of this system.

Transmission to Metropolitan District

The Metropolitan District embraces the entire territory in the vicinity of New York, including that of the Public Service

Plate II.—Route of Transmission Lines to the Metropolitan and to the New England Districts



Company of New Jersey, of the Brooklyn Edison Company, and the territory of the New York Edison Company and its associated companies. The systems are not now interconnected but the present study assumes that the interconnections of these three systems will have been made by the time the St. Lawrence power is available. In order that the cost of the delivered

power shall be as low as possible, it is assumed that, for this market, the transmission lines will extend as directly as possible from the River to the Metropolitan substations, without supplying any other points. Plate II and Table 9 show the routing and mileage of the lines assumed for this purpose.

Four circuits run from Barnhart Island southeasterly, avoiding the Adirondack Park, crossing Lake Champlain near Crown Point, and down the east side of the Hudson River, to a point near Troy, here called Hoosic, the distance from Barnhart Island being 200 miles. Two widely separated rights-of-way are assumed with two circuits on each right-of-way making four circuits on four independent structures, with two independent rights-of-way.

TABLE 9

MILEAGE OF TRANSMISSION LINES FOR THE METROPOLITAN DISTRICT

Termini	Distance (Miles)	Number Circuits	Total Circuit Length (Miles)
1. Barnhard Island-Hoosic...........	200	4	800
2. Hoosic-Elmsford.................	133	4	532
3. Barnhart Island-Elmsford.........	333	4	1332
4. Barnhart Island-Utica............	150	2	300
5. Utica-Newark....................	184	2	368
6. Barnhart Island-Newark..........	334	2	668
Totals.........................	....	6	2000

From Hoosic these four circuits extend without change of any kind to a substation at or near Elmsford, about 20 miles north of the northerly boundary of New York City, and distant 333 miles from Barnhart Island. This point is chosen as the extreme southerly point to which high pressure transmission lines may extend. The substation at Elmsford will have an installed capacity of 450,000 kv-a. Here power will be trans-

formed to 132-kv. and connected by underground cables to the Hell Gate station of the New York Edison system.

In addition to these four circuits to Elmsford, two identical circuits on one right-of-way are to run southwesterly around the Adirondack Reserve to Utica, a distance of 150 miles, and from Utica to a substation in the vicinity of Newark, 184 miles from Utica, making the total distance from Barnhart Island by the westerly route 334 miles, the same as for the easterly route. The Newark substation will have an installed capacity of 225,000 kv-a. It is assumed to be located contiguous to one of the power stations of the Public Service Corporation and therefore to involve negligible cost for connection to that system.

The maximum peak that would be delivered to the Metropolitan District, with a transmission efficiency of 85.0% would be about 640,000 kilowatts,—requiring substation capacity of say, 675,000 kv-a.; with one line of the six as reserve, the deliverable peak to the Metropolitan lines would be 530,000 kilowatts.

Efficiency of Transmission System

The distance from Barnhart Island to the assumed delivery points in the Metropolitan or New England districts is practically the same. Assuming that all of these circuits are in operation, the average energy losses in the transmission will not exceed these values:—

Losses at Average Load

	Per Cent
In the line	10.0
Lowering transformers and connections	1.0
Synchronous converters	2.0
Total average losses	13.0
Energy efficiency of transmission	87.0

The power efficiency at peak load will be somewhat lower than this—about 85%. It is the energy efficiency that is of importance in the estimation of costs.

With an efficiency of 87.0% and with a normal output of 4380 million kilowatt-hours at the generating station, the delivered energy at the low pressure side at the substations will be 3800 million kilowatt-hours. The efficiency of the cable connection from Elmsford will be 97%, making the overall efficiency of this part of the delivered energy 84.5%. The total delivery to the Metropolitan District is 3800 million kilowatt-hours. Two-thirds of this (2540 million) at 97% efficiency or 2460 million kilowatt-hours, will be delivered to the New York City system, and one-third, 1260 million kilowatt-hours, will be delivered to the Newark system, making a total of 3720 million delivered to the Metropolitan distribution system.

Cost of Transmission System

The cost of one mile of 125,000 kv-a., 220-kv. transmission line is given in Table 10; this is the unit cost of line used in the estimates of cost of the transmission system.

TABLE 10

COST OF ONE MILE OF 220-KV., 125,000 KV-A., 795,000 CIR. MIL. ALUMINUM CABLE STEEL REINFORCED SINGLE CIRCUIT TOWER LINE

1. Cleared right-of-way, 250 ft. wide for two circuits (one-half of $6000)		$3,000
2. Towers erected average 5 per mile		8,000
3. Insulators and hardware erected		2,000
4. Conductors erected		6,000
5. Additional as follows:		
Construction equipment	5%	
Commissary and camp	5%	
Engineering	5%	
General expense, including testing miscellaneous and interest	10%	
Total	25%	4,750
6. Contingencies and omissions, approximately	10%	2,250
		$26,000

As previously stated, St. Lawrence power for the New York District to be of use must be connected to the New York distribution system. To minimize this cost, it is assumed that a connection from Elmsford to the nearest generating stations of the New York Edison Company will be adequate and that no cost will be incurred for a connection at Newark. A connection is then assumed to be made from Elmsford to the Hell Gate station of the New York Edison system. For these connections 132-kv. underground cable would probably be installed, and this is the basis of the estimate of cost herein.

A careful analysis of the necessary construction and equipment involved in this connection, made for another purpose, gives the cost of attaching the transmission system from Elmsford to the Hell Gate station as approximately $50 per kv-a. of capacity. On this basis the total cost of connecting the 450,000 kv-a. from Elmsford to the Edison system will be $22,500,000. This sum is included as a charge against that part of the St. Lawrence energy to be delivered to the Metropolitan District.

On these assumptions, the total cost of the transmission lines, stepdown substations, and connections to the distributing system of the Metropolitan District is given in Tale 11.

Table 11

COST OF TRANSMISSION SYSTEM FOR THE METROPOLITAN DISTRICT

1. 2000 miles of 220-kv, 125,000 kv-a. circuit at $26,000 per mile	$52,000,000
2. Substation at Newark, 225,000 kv-a. capacity with 100,000 kv-a. synchronous condensers, at $16	3,600,000
3. Substation at Elmsford, 450,000 kv-a. capacity with 200,000 kv-a. synchronous condensers at $16	7,200,000
4. Total cost of 220-kv. overhead transmission system	$62,800,000
5. Part chargeable to New York	41,900,000
6. Cost of overhead transmission per kv-a. of delivered capacity (675,000 kv-a.)	93

7. Cable connections at 132-kv. from Elmsford to the Hell Gate station, for 450,000 kv-a. at $50 per per kv-a.	22,500,000
8. Cost to deliver 450,000 kv-a. to the New York distribution system	64,400,000
9. Cost per kv-a. of delivered capacity (450,000 kv-a.) to the New York distribution system....	143
10. Cost to deliver 675,000 kv-a. to the Metropolitan district	85,300,000

Transmission to the New England District

The routing of the transmission lines to deliver St. Lawrence power to the New England market is also shown on Plate II, and the mileage in Table 12.

Table 12

MILEAGE OF TRANSMISSION LINES FOR THE NEW ENGLAND DISTRICT

Termini	Distance (Miles)	Number Circuits	Total Length (Miles)
1. Barnhart Island-Hoosic	200	6	1200
2. Hoosic-Millbury	110	4	440
3. Hoosic-Harford	90	2	180
4. Hartford-Millbury	50	2	100
5. Millbury-Medway	20	4	80
6. Totals		6	2000

In this case six circuits on three independent right-of-ways extend from Barnhart Island southeasterly over the same route as for the Metropolitan District to Hoosic, a total distance of 200 miles. From Hoosic four circuits on two right-of-ways run to Millbury by way of Davis Bridge; also from Hoosic two circuits on a single right-of-way run to Hartford and continue from Hartford northeasterly, tying in to the four circuits at

Millbury, thus forming a ring-bus from Hoosic to Millbury. From Millbury four circuits run to Medway, tying in there with the ring-bus of the Boston Edison Company.

As already shown, the total New England market in 1935 will be of sufficient capacity to absorb 3800 million kilowatt-hours, as base load of fairly high load-factor. It is assumed that about 30% of the power goes by way of Hartford and 70% by way of Davis Bridge. A certain amount of power probably would be tapped off at Davis Bridge or Hoosic to supply the systems of the New England Power Company and the Mohawk-Hudson Power Corporation, but no estimate is made of the amount of these taps. Whatever they may be they will tend to make the cost of the energy delivered at Boston somewhat greater than estimated herein.

The substation at Hartford is taken at a capacity of 125,000 kv-a., it being assumed that Waterbury and the Connecticut River territory will be supplied at lower pressure, probably 132-kv., from the Hartford substation. The capacity of the substation at Millbury is 100,000 kv-a. which is assumed to be transformed to 132-kv. and used in the vicinity of Worcester. The remaining 450,000 kv-a. is transmitted at 220-kv. to the Boston ring-bus at Medway, with a 450,000 kv-a. substation at Medway.

These allocations of power to the different substations are estimated on the probable distribution of load. The average cost of the delivered energy will not vary appreciably for any reasonable variations in the assumed distribution of load.

A recent inquiry resulted in the authoritative statement that if the St. Lawrence power is to be connected to the Boston ring-bus after 10 years, there would be substantially no cost chargeable to this connection, for the reason that the ring-bus system by that time would have adequate capacity to handle the St. Lawrence power; it would only be necessary to shift the output of the steam stations from one part of the system

to another. A nominal charge of $1,200,000 is however made for reinforcing the Boston ring-bus. No similar charge is included for the Hartford or Millbury connections.

In order to safeguard the service on these radiating lines from Hoosic, a switching and interconnection station is required there. The scheme of connections for this provides two main bus lines; each feeder from the River can be connected to either or both of the main buses. Similarly, each outgoing feeder to Millbury or to Hartford can be connected to either of the main buses. This provides for good security in operation and permits independent regulation of the feeders. Normally, the Millbury feeders will run from one bus, the Hartford from the other, and the lines from the River will each normally be connected to only one bus.

Based on this layout, the total cost of the transmission lines, switching station, stepdown substations, and connections to the existing distribution systems of the New England district is given in Table 13. It amounts to $65,000,000, equal to $96.50 per kv-a. of rated capacity (675,000 kv-a.) This is about $20,000,000 less than the corresponding cost for the Metropolitan District.

TABLE 13

COST OF TRANSMISSION SYSTEM FOR THE NEW ENGLAND DISTRICT

1. 2000 miles, 125,000 kv-a. circuits from Barnhart Island at $26,000 per mile	$52,000,000
2. Switching station at Hoosic	1,000,000
3. Substation at Hartford, 125,000 kv-a. at $16	2,000,000
4. Substation at Millbury, 100,000 kv-a. at $16	1,600,000
5. Substation at Medway, 450,000 kv-a. at $16	7,000,000
6. Connection to ring-bus at Medway	1,200,000
Total	$ 65,000,000
Total per kv-a. (675,000)	96.50

Annual Cost of Transmission System

These annual costs are the fixed charges on the investment in the system plus the cost of operating and maintenance, including patrolling. The estimated unit costs are as follows:

Lines

12% on cost of lines for interest, profit, depreciation, maintenance, insurance, and taxes; and

$100 per year per mile of circuit for patrolling.

Substations

15% on cost of substations for interest, profit, depreciation, insurance, and taxes (the increase over the line's cost being in depreciation); and

$0.50 per kv-a. of capacity for operation and maintenance.

New York City Connection

12% on cost of connection for interest, profit, depreciation, maintenance, insurance, and taxes.

Switching Stations

12% on cost of switching stations for interest, profit, depreciation, insurance, and taxes; and

$0.10 per kv-a. of capacity for operation and maintenance.

Boston Ring-Bus Reinforcement

12% on cost of reinforcement for interest, profit, depreciation, maintenance, insurance, and taxes.

Based on these unit rates, the annual costs of the transmission system are given in Table 14 for the Metropolitan and for the New England districts, respectively.

TABLE 14

ESTIMATED ANNUAL COST OF TRANSMISSION TO METROPOLITAN AND NEW ENGLAND DISTRICTS

1. Lines:	
(a) Fixed charges, 12% × $26,000 = $3120 per mile, for 2000 miles.	$6,240,000
(b) Patrolling at $100 per mile for 2000 miles	200,000

2. Substations:		
(a) Fixed charges, 15% × \$16 = \$2.40 per kv-a. for 675,000 kv-a.....	1,620,000	
(b) Operation and maintenance \$0.50 per kv-a. for 675,000 kv-a.....	340,000	
3. Total for lines and substations........	8,400,000	\$8,400,000
4. Add for New York City connection, Fixed charges and maintenance, 12% × \$50 = \$6 per kv-a. on 450,000 kv-a.	2,700,000	
5. Total annual cost, Metropolitan district	\$11,100,000	
6. Add for New England district:		
(a) Fixed charges 12% on \$1,000,000 for switching station at Hoosic..................		120,000
(b) \$0.10 per kv-a. for operation and maintenance of switching station at Hoosic....		66,000
(c) Fixed charges and maintenance 12% on \$1,200,000 for Boston ring-bus reinforcement		144,000
7. Total annual cost, New England district...		\$8,730,000

Apportioning the costs for the Metropolitan District given in Table 14 on the basis of approximately one-third of the cost and one-third of the energy allocated to Newark and two-thirds to New York, Table 15 gives the total and unit energy costs:

TABLE 15

COSTS OF TRANSMISSION OF ENERGY

	Amount Million kw-hr.	Unit Cost (Mills)	Total Annual Cost
To New York City System........	2460	3.38	\$8,300,000
To Newark......................	1260	2.22	2,800,000
To Metropolitan District..........	3720	2.98	11,100,000
To New England District.........	3800	2.30	8,730,000

The total annual cost of the generating plant given in Table 5 is $13,000,000—when the interest rate is taken at 4%; for the average delivery of 3800 million kilowatt-hours this is equal to 3.42 mills per kilowatt-hour as the generating cost per kilowatt-hour of delivered energy at Newark or New England.

Apportioning the costs of generating the energy to the costs of transmission as of Table 15, there results:

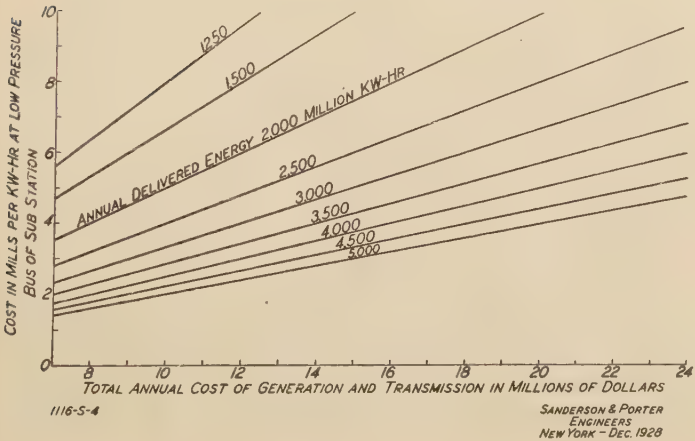
TABLE 16

TOTAL COST OF DELIVERED ENERGY AT SEVERAL POINTS OF DELIVERY WITH 4% INTEREST RATE ON GENERATING PLANT

	Million kw-hr.	Cost per kw-hr.	Total Annual Cost
New York City System	2460	6.75	$16,600,000
Newark	1260	5.64	7,100,000
Metropolitan District, as a whole	3720	6.48	24,100,000
New England District	3800	5.72	21,730,000

FIGURE II.—COST OF ENERGY AT SUBSTATION

St. Lawrence Power Project



A change of 1% in the interest rate assumed for the generating plant investment changes the total annual cost by $1,500,000; it is equal to the addition of 0.40 mills per kilowatt-hour to the cost of the delivered energy.

The total cost of delivered energy given in Table 16 is practically constant regardless of the output of the generating station, which may vary from 5000 to 4000 million kilowatt-hours or less at the River. The average energy available for transmission is estimated to be 4380 million kilowatt-hours, and the total cost per kilowatt-hour for this amount of energy is given in Table 16 for delivery at the several points. Figure II shows these data in graphical form.

Cost of Steam Energy in the Metropolitan District

The economic justification of this development lies in the savings accruing from its use; if then the cost of energy from the St. Lawrence River is greater than the cost of equivalent energy from any other equally reliable source, the project will be unprofitable and therefore should not be built. It is then necessary to estimate the probable cost of steam energy at the several delivery points, under conditions comparable to those of St. Lawrence power.

The annual cost of the energy equivalent to that of the St. Lawrence, when produced in a base load steam plant, depends upon both the capital cost of the steam plant and the cost of production, which in turn depends chiefly upon the cost of coal.

A steam plant for base load operation either in the Metropolitan or the Boston District will be relatively costly, by reason of the high price of real estate, of labor, and the general high cost of all construction in these districts.

It is impossible to fix an exact figure for the cost until all conditions are known; based on the cost of the Hell Gate Station of the New York Edison Company, a cost of $106 per kilowatt installed is taken; this might be less under favorable conditions—but it would probably be greater. The variations

from this unit cost would however not be sufficient to modify materially the conclusions deduced from this assumption.

The "reliable peak capacity" of such a plant is less than the installed capacity by at least the capacity of its largest unit; with all units of the same size this means the capacity of one unit. The St. Lawrence system, with one power unit out, can generate 625,000 kilowatts and deliver about 540,000 kilowatts. To equal this a steam station having an installed capacity of 660,000 kilowatts is assumed; with one unit down, it will equal the St. Lawrence under similar conditions.

Based on these unit costs it is estimated that the total cost of a plant having an installed capacity of 660,000 kilowatts will be $70,000,000.

The operating cost of a steam plant depends primarily upon the fuel economy assumed; current practice indicates that an economy better than 14,000 B. t. u. per kilowatt-hour can be attained, when operating at high load-factor. This economy has been reached in plants of smaller capacity for short periods and it is certain that continued operation at this rate or better is feasible for a base load plant comparable to the St. Lawrence power delivery to the Metropolitan District.

The cost and the quality of the coal will vary from time to time, but there is little reason to expect a material increase in the price of coal in this territory within the next twenty years. The price of high grade bituminous coal of 14,000 B. t. u., in the New York territory is now based on a freight rate of $3.30 per long ton plus the mine price, which may be taken at $2.25 per 2000 pounds, a total of $5.20 per 2000 pounds alongside dock New York Harbor. The cost of coal per kilowatt-hour is then 2.60 mills, in a 14,000 B. t. u. per kilowatt-hour plant.

The cost of labor and supplies (exclusive of coal) for operation and maintenance, when operating at a load-factor of 80% to 100%, will not exceed $5.00 per kilowatt-year of peak; the total annual cost is then $2,750,000 for a peak of 550,000 kilowatts.

The percentage allowed for fixed charges on a steam plant is greater than on a hydroelectric plant, due both to greater depreciation and to higher rates for taxes and insurance. The total overhead for the privately operated steam plant is taken at 12.5%, which, with a cost of $70,000,000 is $8,750,000 per year. The sum of fixed charges and the constant part of the cost of operation and maintenance is then $11,500,000 per year. This is equal to $20.90 per year per kilowatt of the reliable peak of 550,000 kilowatts.

The total cost per kilowatt-hour, allocating this constant cost to the output, plus the coal cost, is given in Table 17 for several outputs of the plant.

TABLE 17

COST OF HIGH LOAD-FACTOR STEAM ENERGY FOR METROPOLITAN DISTRICT

Energy output million kw-hr.	Kilowatt-hours (mills)
3940	5.52
3800	5.63
3700	5.71
3600	5.80
3500	5.88

In order to compete with a modern steam plant, St. Lawrence energy must then be producible for a total cost of say from 5.50 to 6.00 mills per kilowatt-hour. The cost of generating by steam the same total amount of energy as the average from the St. Lawrence, 3720 million kilowatt-hours, at 5.69 mills, would be $21,100,000.

The annual cost of this same amount of energy in the Metropolitan District from the St. Lawrence, as given in Table 16, is $24,100,000, the difference, $3,000,000, is the yearly average loss that would accrue from the transmission of St. Lawrence power to the New York District.

These costs are based on 4% interest on the St. Lawrence generating station; if the interest rate is taken at 6%, cost of St. Lawrence supply will be increased $3,000,000 and the excess cost of the St. Lawrence will be $6,000,000.

Cost of Steam Energy for the New England District

The total annual cost of the St. Lawrence energy delivered to New England, Table 16, is $21,730,000 for 3800 million kilowatt-hours, equal to 5.72 mills per kilowatt-hour. This is less than the cost in the Metropolitan District due to the cost of underground cable connection to the New York City system.

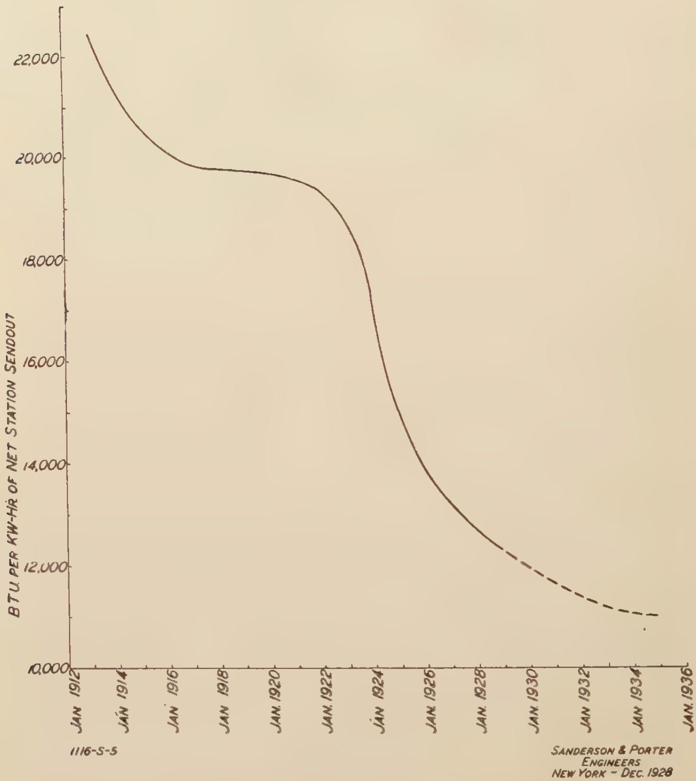
There will be no material difference in fuel costs and hence Table 17 may be taken for the New England District, without change. Table 16 gives the total cost of the St. Lawrence supply to the New England District as $21,730,000; $21,400,000 the cost of equivalent steam supply is $330,000 per year less than the St. Lawrence cost, with interest at 4%. With interest at 6% the local steam cost will then be $3,330,000 less than the St. Lawrence cost.

There are additional sources of energy available for the New England District in the undeveloped water powers of Maine. Recent investigations have shown that there is a possibility of low cost developments in Maine of approximately one million kilowatts total capacity, in units of 30,000 to 75,000 kilowatts, with a total annual output in the average season of approximately 3000 million kilowatt-hours. These developments are all economical, and they can be made step by step, thus effecting a substantial saving in carrying charges. The chief obstacle to a program of hydro development in Maine is the existing statute prohibiting the exportation of electric power from the State, an entirely artificial restraint. This undoubtedly is the best source of energy supply for the New England District when required, as it will be cheaper than the St. Lawrence supply, and in all probability, cheaper than a local steam supply.

Trend of Steam Costs

In the foregoing estimate of the cost of supplying this energy from an equivalent steam plant, a consumption of 14,000 B. t. u. per kilowatt-hour has been taken as the basis. This is a conservative estimate of the probable fuel use in such plant even

FIGURE III.—PERFORMANCE OF TYPICAL STATIONS OF 60,000 KW. CAPACITY, AND HIGHER, PLOTTED AGAINST DATES OF INITIAL OPERATION OF STATIONS.[a]



[a](Portion of Curve from Jan. 1913 to Jan. 1925 inclusive, taken from Annual *Report* of Committee on Power Generation, A. I. E. E. 1925.)

now, and in all probability the economy of base load steam plants will be materially better by 1935 when the St. Lawrence plant is assumed to be in operation.

The general trend of the economy of large steam plants is shown in Figure III, which gives the B. t. u. per kilowatt-hour used in the best steam plants of large size at the different periods. This curve, up to 1925, is taken from the 1925 report on prime movers of the American Institute of Electrical Engineers. We have projected this curve forward to the end of the year 1935.

This estimate is conservative. It is probable that the use of materially higher steam temperatures will lead to greater economy in straight steam cycles. In addition to the straight steam cycle and higher temperatures, there will probably be, among other things, improvements in turbine design to give flat economy curves under very high pressures, binary vapor processes, coal processing, and hydrogen cooling of rotating electric equipment. It is not likely that all of these will be effective by 1935. It seems probable that by the use of the large turbines and boilers now becoming available, unit costs can be held down to such a level as will make many of these improvements commercially economical as soon as development work shows them to be technically practicable.

The net result of these improvements will unquestionably result in a substantial reduction in costs of steam energy.

Long Distance Transmission

There is not much likelihood of substantial reduction in the cost of long distance electric transmission. Two hundred and twenty kilovolts is the practical limit of electric pressures at present and although it is probable that higher pressures may be used within twenty years, it is by no means certain that such higher pressure will lead to a reduction in cost, as higher pressures will involve more costly structures, increase in insulation, and also increase in right-of-way requirements.

It is needless to say that the cost of transmission, as of everything else, will be reduced if the general price level falls. This, however, is beyond present consideration.

Reliability of the St. Lawrence Service

The worth of the St. Lawrence energy at any delivery point is not greater than the cost of otherwise providing the equivalent service. All elements that make up "equivalent service" should be taken into account in the costs, and of these a most important one is reliability of the service. It is stated on the best authority that all St. Lawrence power delivered to the New York District should be relayed by steam power approximately equal to 50% of the St. Lawrence power, and that this steam reserve must be held ready for instant operation; that is to say, a half kilowatt of steam capacity for each kilowatt of St. Lawrence power must be connected to the distribution system at all times ready for instant operation.

The New York Edison Company, in addition to large reserves of generating plant capacity, has a storage battery reserve capacity sufficient to carry the entire peak load of the system for seven minutes. The experience of this company has proved that the high grade service demanded in the New York territory cannot be given without such safeguards. Reserve steam capacity is then an essential element in the cost of the best service.

A 50% relay steam plant to safeguard the delivery of 4800 million kilowatt-hours to the Metropolitan District would have an installed capacity of approximately 275,000 kilowatts. Such a plant would be of lower economy and somewhat lower capital cost than a base-load steam plant; at a unit cost of $96 per kilowatt, the annual cost, including fixed charges at 12.5% and the cost of operation necessary to keep the units on the line, based on $3.00 per kilowatt per year of capacity plus 0.4 tons of coal per year per kilowatt of capacity,—in all $5.00 per year per kilowatt, would amount to approximately $4,675,000 per year, equal to 1.23 mills per kilowatt-hour of the relayed energy, which added to the 6.48 mills derived in Table 16 as the cost

for the Metropolitan District, gives a total of 7.71 mills, as compared with 5.69 mills for steam power.

This additional cost of $4,675,000 per year required to bring the St. Lawrence energy up to the same standard of reliability as that of a local base load steam plant would make the total excess cost of the St. Lawrence energy $7,675,000 per year, with interest at 4% on the generating plant. With interest at 6% the excess cost would be $10,675,000. Inasmuch as the cost of the St. Lawrence energy in the Metropolitan District, even without the relay steam plant, is excessive from a commercial point of view, it is not necessary to give further detailed consideration to the provision of a relay plant. It is desirable, however, to emphasize the fact that to have equally good service, the relay steam plant is essential, and that the costs for such plant must be included.

The same considerations apply to the delivery of the St. Lawrence energy to the New England District. If the same degree of protection is given at the same cost, the total annual cost of the St. Lawrence supply for the New England District, with interest at 4%, is $5,005,000 greater than the cost of energy from a local base load steam plant. With interest at 6%, the excess cost of the St. Lawrence supply becomes $8,005,000 greater than that of the local steam supply.

Other Markets

The remaining markets for the St. Lawrence power are central and eastern New York, from Utica to Albany, adjacent to the route of the New York Central Railroad, and the local market at or near the River.

The total fuel energy generated in 1925 in the Utica-Schenectady District was 227 million kilowatt-hours (Table 7); adding that from water, the total was 500 million kilowatt-hours.

Assuming this to double every ten years, equivalent to an annual growth of about 7%, in 1935 the total would be 1000 million kilowatt-hours and in 1945, 2000 million kilowatt-hours.

The Superpower Report referred to shows that in this up-State district about 50% of the total energy is base load with a load-factor of 80%. It is essential, as already explained, that the St. Lawrence energy be utilized at high load-factor in order to minimize the cost of transmission and generation.

The maximum amount of energy that could be supplied from the St. Lawrence to this district in 1935 would then be approximately 500 million kilowatt-hours; this would of necessity supplant steam or other hydro power then in use. At 80% load-factor the peak load would be 71,500 kilowatts, requiring, with reserve capacity, a transmission system of a capacity of about 100,000 kv-a.

This market is so inconsiderable that it cannot be treated as an independent supply; to supply it from the St. Lawrence, power should be taken from the circuits assumed to go to the Metropolitan District and the energy for the Metropolitan District would then be correspondingly reduced; this market is then dependent upon the supply to the Metropolitan District.

Estimating on this basis, the allocated cost of the transmission system to Utica, 150 miles, will be approximately \$5,500,000 for the cost of the transmission lines and 100,000 kv-a. substation capacity; the annual charges would be approximately \$750,000, making the cost of the transmission approximately 1.50 mills per kilowatt-hour, for 500 million kilowatt-hours.

The two circuits from Utica to Newark would then have smaller conductors, and the cost of these lines would be reduced by about \$2000 per circuit-mile, a total of \$725,000, and the annual charges by 12% of this, equal to \$87,000. For the Newark supply the annual cost would then be:

Total annual cost of transmission to Newark (Table 15)		\$2,800,000
To be deducted:		
(a) Amount allocated to Utica	\$750,000	
(b) Charges saved on lines	87,000	837,000
Cost at Newark, with Utica load on		\$1,963,000
Energy to Newark (1260-500) = 760 million kw-hr.		
Cost per kw-hr. of transmission at Newark		2.58 mills

This plan would give relatively cheap energy, 4.5 mills per kilowatt-hour, at Utica, but at the expense of increased cost of the larger supply at Newark.

The supply to this market then depends entirely upon taking up the greater Metropolitan market, which has been proved to be economically unsound. It therefore is not an important element in the case.

The remaining single market is at the River,—in the establishment of large electrometallurgical or electrochemical industries. This would probably be profitable in the long run, but it is impossible to estimate how long it would take to build up such industries, or what prices they could afford to pay for power. Such use of the power, in part, is probable, whatever disposition may be made of the major portion of the supply.

Should the requirements of the electrochemical and electrometallurgical industries warrant such establishments at the River, and if all of the St. Lawrence power could not be sold to these industries, a portion could be transmitted to Hoosic for distribution in New England and another portion to Utica for distribution from that centre. At the present time there appears to be probability of the combination under one directive control of the most important power systems from Niagara across the State, down through New York, New Jersey and Philadelphia, and possibly further south. The New York Central Railroad will probably electrify within the next ten years, requiring 175,000 kilowatts demand, and one billion kilowatt-hours; this will be an important new load.

Power from the St. Lawrence might well be fed into such an interconnected system at Utica and the one billion kilowatt-hours could be absorbed there by the combined power systems, and used in part for the New York Central Railroad. In addition, there could be delivered at Hoosic one billion kilowatt-hours, and the 50% remaining St. Lawrence power could be used for manufacturing near the River. The cost of the transmission system necessary to connect the St. Lawrence power at Utica

and Hoosic with the assumed Superpower System, using the same unit costs as elsewhere in this Report, amounts to $11,-000,000 for Utica, and $13,600,000 for Hoosic, a total of $24,-600,000 for the two. The total annual cost would be $1,546,000 for Utica, and $1,868,000 for Hoosic; for the two, $3,414,-000. The average cost of the transmission per kilowatt-hour delivered to these two points would then be 1.71 mills.

Résumé

The net result of this study is that either the Metropolitan District or the New England District will in 1935 furnish a satisfactory market both as to quantity and as to load conditions to absorb readily the entire St. Lawrence energy available to the United States; but that the excess annual cost of the St. Lawrence supply, when supplemented by steam reserves adequate to safeguard its operation and so to place it on a parity with steam energy from modern steam plants situated at the load centers, will be $7,765,000 for the Metropolitan District, and $5,005,000 for the New England District, when interest on the cost of the works at the River is included at 4%; each 1% increase in the interest rate will add $1,500,000 to the excess cost of the St. Lawrence supply. The project is therefore economically unsound in connection with a segregated transmission system to either of these markets. It might, however, be economical in connection with electrochemical, or electrometallurgical industries located at the River, taking a substantial part of the energy, and with the remainder of the energy transmitted to Hoosic and Utica for distribution over a then existing Superpower System.

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